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THE AMERICAN UNIVERSITY IN CAIRO
SCHOOL OF SCIENCE AND ENGINEERING

**“USERS’ OBSTACLES TO ICT ADOPTION IN EGYPTIAN
CONSTRUCTION COMPANIES”**

A THESIS SUBMITTED TO THE SCHOOL OF SCIENCES AND
ENGINEERING IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF

Masters of Science in Construction Management

To

Construction Engineering Department

By

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Under the supervision of

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THE AMERICAN UNIVERSITY IN CAIRO, EGYPT
FALL 2018**

Acknowledgment

My journey as a M.Sc. student at AUC was definitely a very special one. I went through lots of challenges that I eventually passed, thanks to the supportive people around me.

I would like to thank my family and my fiancé for their unconditional support and for always giving me the power to continue. I am thankful to Dr. Samer for allowing me to research a not-so-typical topic in the Construction Engineering program and supporting me all the way through. I would also like to thank all the Doctors and staff in the Construction Engineering program for facilitating everything to make this thesis possible.

Abstract

Construction companies often face resistance from some employees when adopting a new Information and Communication Technology “ICT” at the workplace. Technology Acceptance Models in the literature indicated the factors affecting the employees’ behavior. However, none of these models were applied in the Egyptian Construction Industry context to test their validity.

In this thesis, 10 factors were collected from different Technology Acceptance models and their validity were tested in the Egyptian Construction Industry context through questionnaires survey. The behavior of employees in Egyptian Construction companies was validated to be consistent with the described behavior in the literature.

The 10 factors were synthesized to develop a simple “Evaluation tool”, consisting of a series of easy to comprehend questions, to be used by managers to evaluate each employee’s likelihood to accept or reject a new ICT. The Evaluation tool was validated through interviewing experts who indicated its usefulness in detecting obstacles standing in the way of ICT acceptance.

Then the validated factors were represented in the form of logical causal chains. The causal chains were further extended by adding more “causes of the causes” to develop a “Causal Loop Diagram Model”. In order to extend the causal chains, knowledge from psychology, communication and management domains had to be added to the model. The added pieces of knowledge enriched the model with new aspects of the ICT acceptance problem that were not explored in the traditional widely used technology acceptance models. The model was validated through expert interviews.

By careful analysis of the big picture of the ICT acceptance problem, three analogies were concluded that compared employees’ behavior in reaction to new ICT to “Investors”, “Kids” and “Cavemen”. It is concluded that employees resist new ICT if it didn’t provide a technical advantage (saving time or effort) or a

psychological advantage (making the employee have higher social or importance rank inside the company).

It is recommended that managers give more attention to the psychological implications of a new ICT rather than focusing most of their efforts on improving technical aspects of the new ICT.

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List of Abbreviations

ICT	Information and Communication Technology
TAM	Technology Acceptance model
IDT	Innovation Diffusion Theory
LUM	Lazy User Model
CLD	Causal Loop Diagram
BIM	Building Information Modeling
KPI	Key Performance Indicator
ROI	Return on Investment

Chapter I: Introduction

I.1 Background

Advancements in the Information and Communication Technologies increase every day. Different Industries react to these advancements by adopting more ICT into their processes. ICT ultimately help businesses reduce operational costs and increase revenues (Linderoth and Jacobsson, 2008; Sepasgozar et al., 2018). It is imperative that companies stay up to date with new technologies in order to survive against competition.

Likewise, Construction companies are moving towards adopting more Information and Communication Technologies “ICT” systems, tools and applications. ICT is used to coordinate and manage the information flows internally inside the company and externally with other stakeholders.

I.2 Definition of ICT

Information and Communication Technologies (ICT) refers to technologies and equipment that can be used to **collect, store, retrieve, transmit and manipulate** data. It refers to tools and systems that can help people in a company to interact digitally. Examples of recent ICT advances are:

- BIM systems
- Drones
- Wearable technologies
- Mobile technologies
- Machine learning applications
- Computer Vision Technologies

I.3 Technology adoption process definition

Technology adoption is the process by which an employee accepts and integrates a new technology into his normal daily tasks without feeling rage or rejection to having to use this new technology (Sepasgozaar et al., 2018). In literature,

technology adoption at the individual level is sometimes referred to as “technology acceptance”. For the purpose of this research, the terms “adoption” and “acceptance” will be used interchangeably.

The process of technology adoption has a number of phases, starting with being an idea, through to the implementation phase. Acknowledging the need for a certain technology by the leaders of a company is just the first step of the process of adoption and it holds a little contribution to the probability of success of the implementation of the technology. A “series of interrelated activities” should be done in order for the technology to be part of the normal work practice inside the company (Sepasgozar et al., 2018).

Table 1 shows a breakdown of the technology adoption process at the organizational level

Phase 1	Phase 2	Phase 3
Pre-Adoption	Adoption	Post-Adoption
1. Identification of possible solutions 2. Study feasibility of options	3. Information Analysis 4. Practical Evaluation 5. Decision to buy the technology	6. Training & Implementation 7. Assessment

Table 1 The Technology Adoption process phases (Sepasgozar et al., 2018)

There are several possible activities that could be done to make employees less resistant to switch to a new technology. However, knowing which activities can expedite the technology diffusion rate and are truly supportive to successfully implement the technology is not an easy task (Sepasgozar et al., 2018).

The increased value and importance of new technologies motivated the research to ease the technology adoption process and increase its smoothness.

I.4 Problems hindering the adoption process

Despite the many benefits that can be reaped out of ICT systems and tools, the construction industry is relatively slow in adopting new ICT technologies compared to other industries. Adopting technologies in companies is usually associated with several barriers. Understanding these barriers can help managers overcome them and increase the likelihood of success of the technology adoption process. (Sepasgozar et al., 2018)

Efforts have been made to identify reasons behind this slow adoption rate. Different models were developed and tested empirically in the construction industry context. This research aims to uncover insights about the problem from two levels:

- Technical problems: Identifying technical and technology related problems that discourage the employee from using a new ICT.
- Coordination problems: Identifying contextual and organizational problems that discourage the employee from using a new ICT.

Chapter II: Literature review

In this chapter, models that tried explaining the employees' behavior in reaction to new technology introduced at the workplace are reviewed. Then different construction industry specific reasons for slow ICT adoption are shown. After that, other communicational and psychological aspects that could add explanations to the ICT acceptance problem are reviewed.

II.1 Conceptual Models predicting acceptance

Over the last decades, there has been attempts to model the technology adoption process. Construction industry researchers empirically tested some of the models to explain the adoption of ICT in general and some specific ICT like Building Information Modeling "BIM". Some of the models used are:

- Lazy User Model (Tétard and Collan, 2009)
- Technology Acceptance Model "TAM" (Davis et al., 1989)
- Innovation Diffusion Model "IDM" (Rogers, 2003)
- Extended Technology Acceptance Model "TAM" (Venkatesh and Davis, 2000)

II.1.1 Technology Acceptance model (TAM)

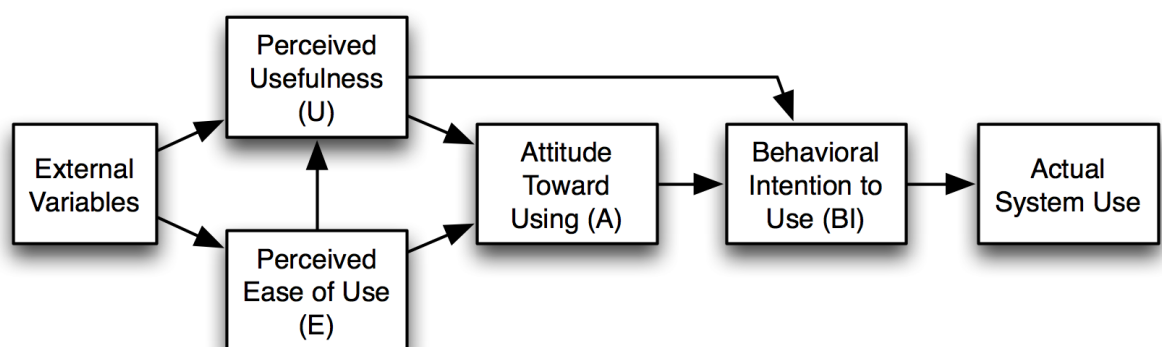


Figure 1 Technology Acceptance Model "TAM" (Davis et al., 1989)

Technology Acceptance Model "TAM" is a model in behavioral psychology developed by Davis et al. (1989) used to explain what motivates people into using information systems. It describes that two factors could be used to predict whether a

person will use a new information system or not. These factors are perceived usefulness and perceived ease of use. Perceived usefulness is described as the expected benefit and performance improvement expected out of usage. It is a measure of expected outcome (Kim et al., 2007). Perceived ease of use is described as the degree to which the expected task will be free from effort. The model describes that a person runs the scenario of using the new technology in his head before actually using it. "TAM" has become a widely used model to predict the acceptance and use of information systems.

Davis et al., (1989) describes the model as follows: "Because new technologies such as personal computers are complex and an element of uncertainty exists in the minds of decision makers with respect to the successful adoption of them, people form attitudes and intentions toward trying to learn to use the new technology prior to initiating efforts directed at using. Attitudes towards usage and intentions to use may be ill-formed or lacking in conviction or else may occur only after preliminary strivings to learn to use the technology evolve. Thus, actual usage may not be a direct or immediate consequence of such attitudes and intentions."

The TAM model gained a lot of popularity in research. Peansupap and Walker (2005) found empirically that attitude is not directly linked to intention for adoption. They concluded that TAM maintains its validity and robustness even when attitude factor is omitted. On the other hand, Venkatesh and Davis (2000) claim that a lot of theories and empirical studies accumulated in favor of TAM over the years.

II.1.2 The Innovation Diffusion Theory (IDT)

The Innovation Diffusion theory is a theory that describes the rate of diffusion of a new innovation in a social system. It describes that a new innovation is first adopted by innovators (by those who believe in the cause behind the innovation and are willing to try something new). He segments the adopters into five segments: innovators, early adopters, early majority, late majority, and laggards. He differentiate between the segments by their innovativeness, which is the degree to which they are willing to try a new innovation. He explains that the user-related factor that determines which category they will belong in is their

innovativeness degree. This factor varies across people, but generally in a social system, the categories will be divided as shown in the figure 2.

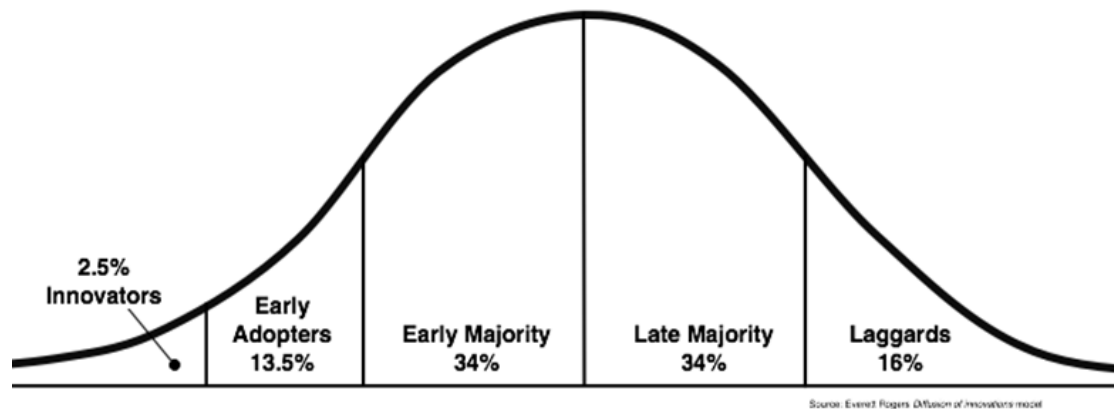


Figure 2 Innovation Diffusion Theory "IDT" curve (Rogers, 2010)

(Rogers, 2003) describes the innovation-related factors that control the rate of diffusion of an innovation to be:

- **Observability:** how obvious the benefits of using the innovation will be to other people who realizes that someone is using this innovation?
- **Advantages:** how much advantages will the new innovation have over current practices?
- **Compatibility:** How much deviation to social norms, cultural values, previous ideas and beliefs about needs is required to adopt this new innovation
- **Trialability:** How reversible are the effects of adopting this new technology if someone did not like it? Is it a high risk to use it?
- **Complexity:** Could it be understood and used smoothly?

The factors are shown in figure 3.

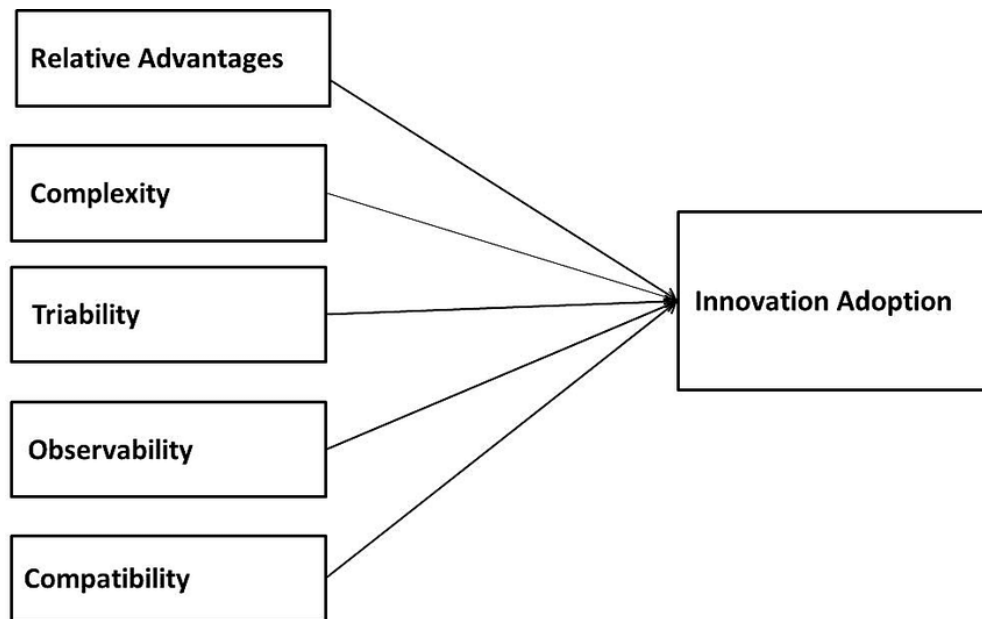


Figure 3 Innovation Diffusion Theory factors (Rogers, 2010)

Hosseini et al., (2016) used IDT to investigate reasons behind late adoption of BIM in Australian Construction small and medium Enterprises (SMEs). Through questionnaires with SMEs, he found that lack of certainty of the Return on Investment (ROI) expected out of using BIM is the main contributing factor behind a slow adoption rate of this technology. Panuwatwanich and Peansupap (2013) used IDT to analyze 45 discussion threads on a social network for professionals (LinkedIn) and found that the most common factors hindering BIM adoption are the difficulty to alter the existing processes and workflow and the difficulty of adjusting the work culture. Moreover, the misleading expectations about what how BIM would improve the current practices led to disappointment and aborting the BIM usage in some firms Panuwatwanich and Peansupap (2013).

II.1.3 Combination of TAM and IDT for explaining BIM Technology Adoption

The adoption of the BIM technology took a lot of attention recently in research. Although BIM is now commoditized and used by most of the companies in some countries, there still is a slow rate of adoption in other countries (Xu et al., 2014).

Some construction industry professionals find BIM too complicated and are not sure they are getting full value out of it which is hindering the adoption process (Howard and Björk, 2008).

Literature review indicates that efforts are spent to find out the factors that determine whether BIM will be adopted successfully in a certain company or not. Xu et al. (2014) used a model that combines both the TAM and IDT in order to explain the reasons behind slow BIM adoption. They indicated that BIM is widely adopted in some countries, but limitedly adopted in others and they explained that they used their new model to explain this observation. The model was validated through surveys on the Chinese construction industry.

(Xu et al., 2014) integrated factors from TAM and IDT into the hypothesized model shown in the above figure. It was validated empirically using survey data from the Chinese construction industry.

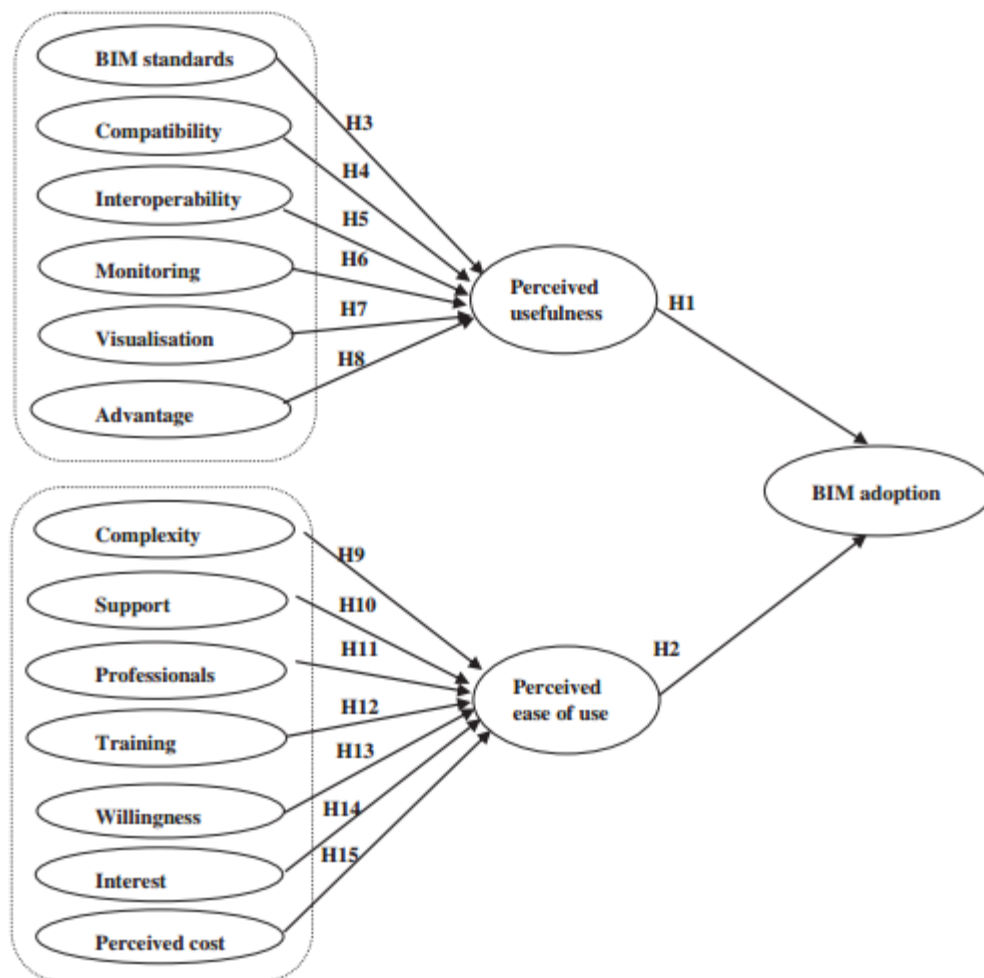


Figure 4 an integrated TAM-IDT model for BIM (Xu et al., 2014)

The study used employees of construction companies as respondents to the questionnaire survey and followed surveys by expert interviews. It used statistical analysis to validate the hypothesized factors.

It was found that eleven out of the thirteen factors could be correlated with adoption rate of BIM in the Chinese Construction Industry. Those factors are:

- Technology factors:
 - **Interoperability** between applications software: lack of interoperability between different types of software is a major obstacle to the success of BIM adoption
 - **Compatibility** of software: lack of the ability to seamlessly exchange data between different BIM applications hinders BIM adoption

- **Monitoring** of construction quality and progress: Presence of the feature of the ability to monitor quality and progress affects an individual's perceived usefulness of adopting BIM.
- **Visualization** of the design effects: The ability to visualize designs affects an individual's perceived usefulness of adopting BIM.
- **BIM standards**: The development of open standards, such as Industry Foundation Classes (IFC), that support exchange of information between different project stakeholders affects perception of ease of use.
- Organizational factors:
 - **BIM professionals**: staff knowledge and experience influences perception of the ease of use of BIM technology.
 - Professional **training** of BIM technology:
 - Support of senior management or owners
- Attitude factors:
 - **Interest** in learning BIM
 - **Willingness** to use BIM
 - **Perceived cost** of the BIM technology.

Two factors were not significant:

- **Relative Advantage**: It was found that an individual's perception of the generic benefits of BIM technology does not influence his perception of the technology being useful in the individual context.
- **Complexity** of the software

Xu et al. (2014) found that factors related to attitude had much stronger effects on perceived usefulness (PU) which in turn affects greatly the adoption likelihood. Xu et al. (2014) described this finding to be “striking”. This finding implied that improvements in the “attitude” of the potential adopters of BIM would be the most effective factor to work on in order to increase successful adoption chances (Xu et al., 2014). This finding is also supported by (Hartmann and Fischer, 2008) who indicated that barriers for BIM adoption are shifting from technical issues to personnel issues.

II.1.4 The Lazy user model “LUM”

The lazy user model of solution selection “LUM” is a model in information systems proposed by (Tétard and Collan, 2009) that explains how an individual selects a solution to fulfill a need from a set of possible solution alternatives. LUM expects that a solution is selected from a set of available solutions based on the **amount of effort** the solutions require from the user – the selects the solution that carries the least effort. The model is applicable to a number of different types of situations, but it can be said to be closely related to technology acceptance models.

The model draws from earlier works on how least effort affects human behavior in information seeking and in scaling of language (Xu et al., 2014). Earlier research within the discipline of information systems especially within the topic of technology acceptance and technology adoption is closely related to the lazy user model.

II.2 Managerial Aspects of the ICT acceptance problem

II.2.1 Role of Key Performance Indicators (KPIs) in Construction companies in incentives shaping

Construction companies are usually organized in project based structures that changes with each project. It is usually assumed that ICT adoption behavior is the same in permanent structured teams as in project based structured teams which is proven wrong by Linderoth and Jacobsson (2008). They found that in project based mood of organizing, where cost and time are important KPIs for the project success, introducing ICT takes time to deploy which conflicts with the nature of projects. Instantaneous benefits need to be visualized in order to strike motivation for using the new ICT. Moreover, the indefinite duration of projects makes it unclear whether ICT adoption will reap its benefits over the course of the project or not which is a hindering factor for adoption to take place (Orlikowski, 1996).

Newell et al. (2006) highlights that there is a fundamental conflict between technology adoption requirements and the project success criteria that acts as a barrier for adoption. Technology adoption requires changing work structures and processes, which takes time to implement smoothly. On the other hand, projects must end within a limited time frame. So implementing technology will increase the probability of delay of a project completion date which is undesirable by project stakeholders. In other words, technology will bring long term benefits but short term losses.

II.2.2 The importance of coordination with different stakeholders

Unlike other industries, construction industry is more fragmented. The design and execution are done by different teams. In any construction project, there typically is a design firm, a contractor, subcontractors, a project management consultant, a design consultant and several suppliers. The construction industry has more stakeholders than many other industries. There is no integration of the whole value chain within one firm. All parties must collaborate in order to complete a project.

This high collaborative nature makes individual attempts by a certain company to adopt a technology fail due to lack of a collective decision by all stakeholders. (Dainty et al., 2007). The stakeholders must adapt their workflows and processes to be able to cope with the new ICT, used by one of the stakeholders, which makes a new ICT implementation by one of the stakeholders alone hard to succeed. Coordinating with other stakeholders is a key factor in ensuring success of a new technology implementation.

II.3 Communication and Psychological aspects

II.3.1 The Employee's Subjective Perception of ICT vs. Objective Reality

Attempts to increase ICT adoption by only improving the technical aspect of the technology overlooks the importance of organizational context and communication issues (Wikforss and Löfgren, 2007).

In many situations, managers believe that the ICT will make employees life easier, yet they face “unexpected” rejection of ICT by employees. Constantinides and Barrett (2006) argues that the employees frame of reference and perspective of contextual factors plays an important role in determining ICT adoption success and therefore should be analyzed.

A clear distinction between “Objective Reality” and “Subjective Perception of an employee” is a key in understanding the problems an ICT introduction is making. Objective reality is the actual situation of the company, while subjective perception is the translation of this reality into an employee’s mind. (Harari, 2014a)

In this section, the literature explaining the employee’s perception, conscious decision making processes and unconscious instantaneous reactions to ICT is reviewed. Then methods by which managers could affect the employees’ frame of reference and increase chances of technology adoption in their company are reviewed.

II.3.2 Background on physiology of the human brain

The decision to reject ICT is **not** made by employees after logically considering pros and cons of this new ICT. However, the decision is taken instantly by the employees’ “gut feeling”. This decision is made by the limbic brain which is the primitive part of our brain. It is also called “the crocodile brain” in (Klaff, 2011). And this decision by the limbic brain feels right because the limbic brain also controls emotions. However, people usually lack ability to articulate words and describe why they think the decision they took, which is the decision to reject ICT in this case, is the best for them. The problem is most managers ask the employee to explain their reasons for not being willing to use the new ICT, which is not always the best strategy to identify the underlying problem. The following quote from Henry Ford suggests that people are not good at explaining what they really need: *“if I had asked people what they wanted, they would have said a faster horse.”* (Sinek, 2009)

A good manager should dive deep into his employees' minds to understand the underlying reasons behind their behavior in order to design the best solutions at the least cost.

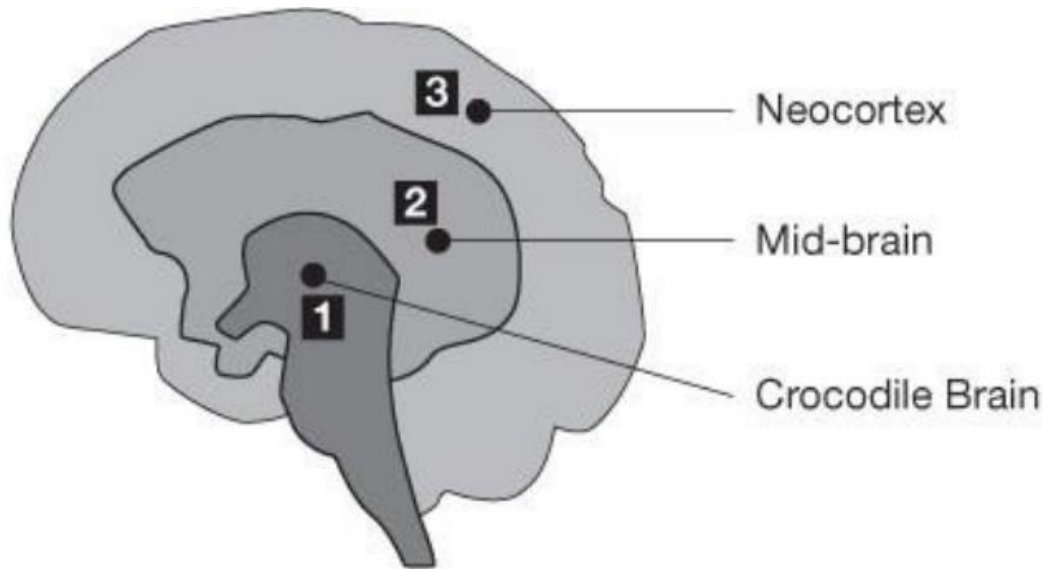


Figure 5 Brain Structure (Klaff, 2011)

Klaff (2011) describes that the brain consists of three main parts:

- 1- The crocodile brain: It is responsible for the initial filtering of the incoming messages and it is responsible for strong basic emotions like fear. This part is the real decision maker in most of the situations that a person goes through. It produces most automatic “fight” and “run” responses. The main function of this part is to keep us alive. It helped early humans survive predators and dangerous life-death situations. Although the capacity of the crocodile brain to think and logically evaluate pros and cons of a decision is minimal, it still controls most of our decisions. The crocodile brain is concerned about survival.
- 2- Mid-brain: It is responsible for perspective and making meaning out of social settings.
- 3- Neocortex: It is responsible for problem solving and consciously thinking about complex issues to produce logical answers. It is also responsible for formulating words to be communicated to others.

So when the brain rejects the ICT, this is a sign by the crocodile brain that some needs are in endangered.

The struggle some Managers have when trying to convince employees with an ICT could be described as follows:

- The manager learns about the new technology idea. The idea appeals to his crocodile brain, because the perceived benefit for his company (and accordingly for himself) is higher than the perceived cost.
- He tries to formulate logical reasons using his neocortex to communicate to the employees to convince them to adopt the new technology. He does the following:
 - He uses some logical arguments about why the technology will be beneficial to the company.
 - He uses some logical arguments about why the technology will benefit the employee himself.

- The communicated words are received by the employee's crocodile brain.

The crocodile brain would label the message as follows:

- Label: Dangerous. Reaction: Ordering employee to run from this ICT idea. This ICT is not safe.
- Label: Not interesting. Reaction: Ordering employee to ignore the message received.
- Label: Interesting and not dangerous. Reaction: Pass information up to the neocortex. (Few percentage of the manager's words)

Klaff (2011) estimates that around 90% of the received information by the crocodile brain do not get sent up to the neocortex and gets a reaction instantly by the crocodile brain.

Minsky (1988) explains in his book, society of mind, how this labeling happens. Any message received by the employee's five senses, triggers a network of memories. The triggered memories help the employee do two things:

- Understand the message communicated using previous knowledge about the discussed subject.

- Get alarmed if this message remind the employee unconsciously about any fear or insecurity he has.

An example of this physiological mechanism is shown in figure 6.

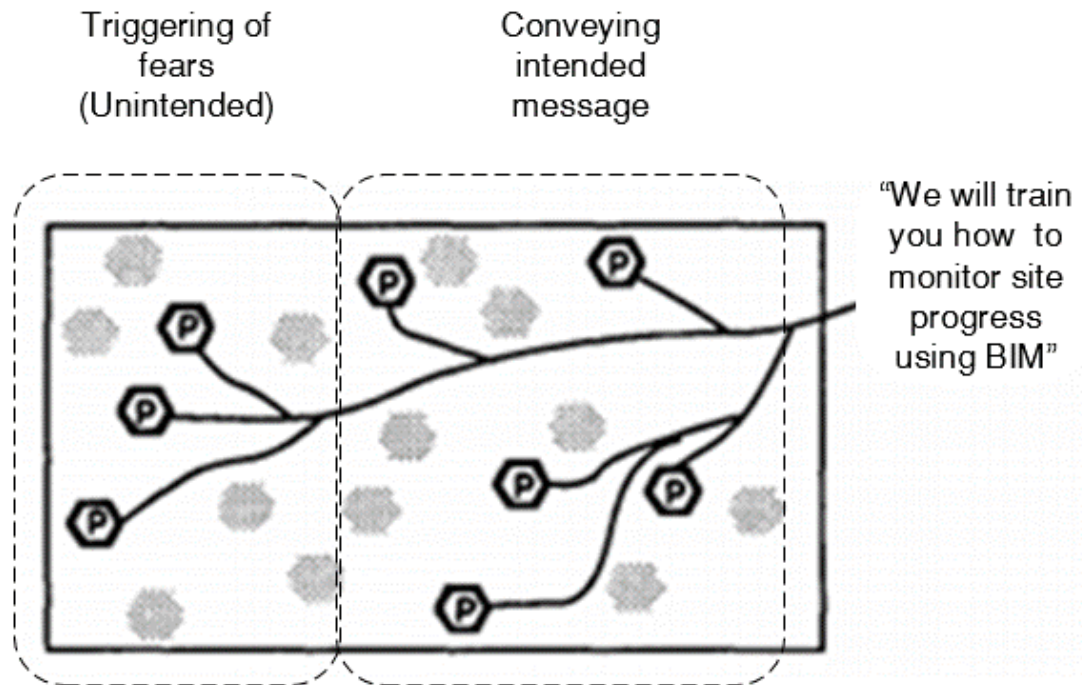


Figure 6 Example of an employee making sense of a message said by a manager. (Minsky, 1988)

Examples of the fears that may get triggered in this example are:

- "You will need to train a lot on this new ICT to be skilled in using it and this takes a lot of effort. You better save this effort"
- "Other younger employees will be more competent in this new ICT, so your value in the company may decrease. You better reject this new ICT."

When subtle unconscious fears are triggered, the employee will do two things:

- Resist the ICT
- Subconsciously not consider all the other benefits that the ICT would bring him. This is because this consideration of benefits is done in neocortex. However, in case of triggering of fears, the crocodile brain do not send the messages received by the employee to the neocortex to be processed. Instead, crocodile brain would instantly label the ICT "dangerous". Employees have a lot of uncommunicated fears and insecurities, and managers sometimes are not aware of these fears when communicating with employees.

There is another big problem that occurs after the employee decides (subconsciously) to resist the ICT. The problem is Managers get frustrated (subconsciously) when they see the employee not considering the benefits of the ICT communicated by the Manager. This engages the managers and the employees in the following loop (Wolstenholme, 2003):

- The Manager gets frustrated from the employee's resistance and inability to consider the benefits of the ICT. So the manager's attitude towards the employee becomes less cooperative.
- The decrease in the Manager's cooperative attitude with the employee triggers more fears, which triggers more resistance to the ICT.

The struggle that managers have in communicating the value to their employees is a "biological problem". They use their neocortex to form ideas and messages that can be well processed and understood only by the neocortex, but forget to design their words to appeal to the first gate, the crocodile brain (Sinek, 2009). The benefits of the ICT would be considered, only when messages can pass safely from the crocodile brain gate to the neocortex.

II.3.3 Fundamental needs

Managers in the construction industry frequently have troubles communicating the benefits of the ICT they are introducing to their company. The trouble emerges mainly from unintentional threatening to the employee's needs. So understanding what are the employee's needs that could be hurt would help managers design their words and solutions as not to threaten any of those needs. In this section, the fundamental needs of employees are reviewed

Maslow's hierarchy of needs (figure 7) is a theory in psychology that represents all human needs in five levels. Maslow initially stated that each level must be satisfied before the next level emerges to make any value to the person (McLeod, 2007). However, he later clarified that "satisfied" should not be at "an all or none basis".

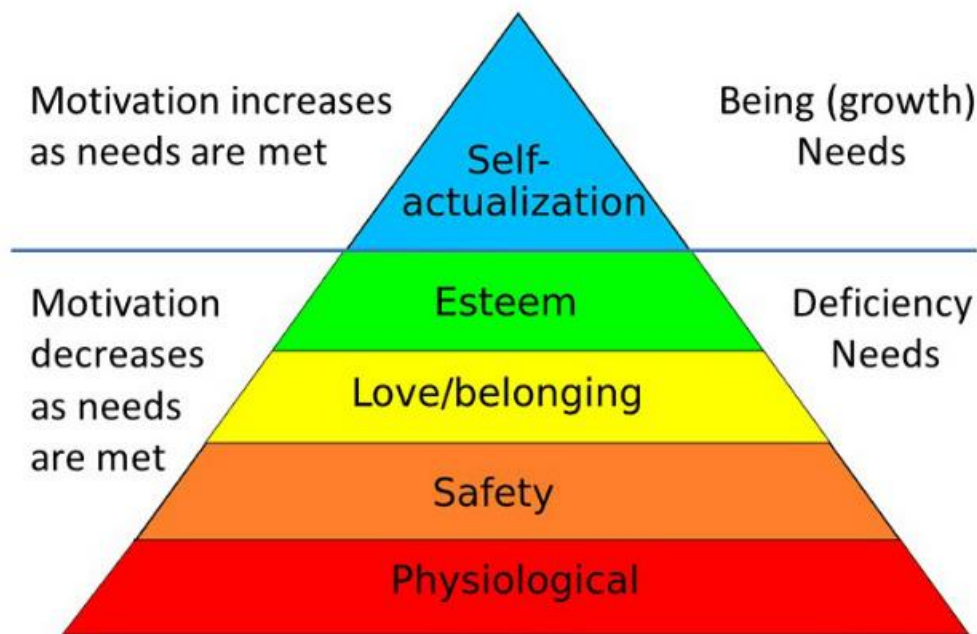


Figure 7 Growth needs vs. Deficiency needs (Maslow's Hierarchy of needs) (McLeod, 2007)

The five level model is segmented in two buckets:

- Deficiency needs (D-needs): The lower four levels. These needs arise due to deprivation. The motivation to fulfil these needs become stronger the longer the deprivation duration.
- Growth/Being need (B-needs): The upper level. These needs do not decrease as they are satisfied. They may even grow as they are being satisfied.

The difference between both types of needs is best expressed as follows:

"When a deficit need has been 'more or less' satisfied it will go away, and our activities become habitually directed towards meeting the next set of needs that we have yet to satisfy. These then become our salient needs. However, growth needs continue to be felt and may even become stronger once they have been engaged."

(McLeod, 2007)

At the bottom of the hierarchy are the physiological needs that are crucial for survival. The next levels up are safety needs, Belongingness needs and Self-Esteem needs, followed by Self-actualization needs. Examples of needs:

- Physiological: Food, water, warmth, rest
- Safety: Security, job security
- Belongingness: Family relations, Friendships, relations with colleagues
 - Our need to belong is not rational. However, it is there in all types of people with all types of cultures. (Sinek, 2009) We have a constant need to belong to a group of people with shared beliefs and values. We make sense of who we are by sticking to some beliefs and values that are shared by our people or “our tribe”. We crave the feeling of belonging to a larger group who shares common values and beliefs. Likewise, Employees like to feel they belong to the people in the company they work for.
- Esteem: Prestige, Feeling accomplishment, feeling respected in the workplace, Feeling appreciated by managers
- Self-Actualization: When someone is achieving his own potential, contributing to a community he cares about, working towards a higher value he believes in

II.3.4 Fundamental fears

Albrecht (2012) argues that all human fears can be traced back to five fundamental fears (shown in figure 8).

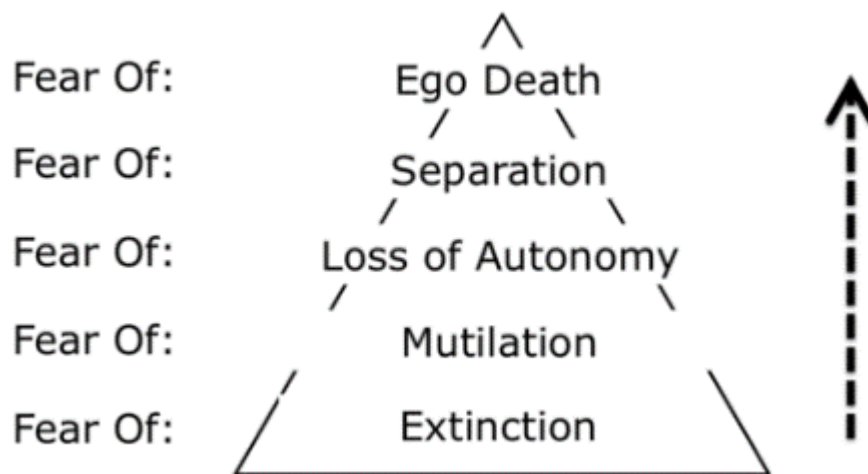


Figure 8 A representation of all possible kind of fears that a human being can have (Albrecht, 2012)

The fundamental fears are:

- **Extinction:** the fear of annihilation, of ceasing to exist. This is a more fundamental way to express it than just calling it "fear of death." The idea of no longer being arouses a primary existential anxiety in all normal humans.

The lazy user model (Tétard and Collan, 2009) indicated earlier emerges from an employee's instinct for saving valuable energy. It is a natural instinct, which was necessary for evolution, to be inclined to save energy and choose the easiest alternative when comparing between options. This behavior emerges from subtle old fear of extinction. Spending a lot of effort could harm a person's health and prevent him from focusing on pursuing other needs.

- **Mutilation:** the fear of losing any part of our precious bodily structure; the thought of having our body's boundaries invaded, or of losing the integrity of any organ, body part, or natural function. Anxiety about animals, such as bugs, spiders, snakes, and other creepy things arises from fear of mutilation.

This fear is not a concern in the case of ICT introduction. No reviewed literature indicated a possibility of this fear in the ICT adoption context.

- **Loss of Autonomy:** the fear of being immobilized, paralyzed, restricted, enveloped, overwhelmed, entrapped, imprisoned, smothered, or otherwise controlled by circumstances beyond our control. In physical form, it's commonly known as claustrophobia, but it also extends to our social interactions and relationships.

(Spreitzer and Doneson, 2005) indicates that some managers would force change over employees. This could lead to an employee's fear of being controlled and losing freedom of choice of what to do at work. When a manager forces ICT on employees, this fear of losing autonomy might be triggered.

- **Separation:** the fear of abandonment, rejection, and loss of connectedness; of becoming a non-person—not wanted, respected, or valued by anyone else

Magee and Galinsky (2008) discuss that in any organization, a subtle social hierarchy is formed between employees. This hierarchy is based mainly on power and status. The level of skill an employee has in a company is highly correlated with his rank in the perceived hierarchy by employees Cheng and Tracy (2014). Employees have a fear of losing relative status compared to other employees. This suggests that when a new ICT is introduced, an employee may fear that other employees could become more skilled and proficient with that ICT; which would in turn, lower the employee's status and value in the organization. This fear could trigger resistance to the ICT subconsciously.

- **Ego-death:** the fear of humiliation, shame, or any other mechanism of profound self-disapproval that threatens the loss of integrity of the Self; the fear of the shattering or disintegration of one's constructed sense of lovability, capability, and worthiness.

Meyer (2011) suggests that age affects the likelihood of ICT adoption in companies. This could be traced back to lack of skills in using ICT among older workforce and a fear of losing the old employee's "constructed sense of worthiness" in the company.

II.3.5 Employee's valuation of ICT that brings both personal benefits and losses

II.3.5.1 Loss aversion

The loss aversion concept is a theory that says that the pain of losing something is higher than the pleasure of gaining something of the same magnitude.

(Kahneman et al., 1991). Although this may seem irrational, but this mechanism was necessary for the evolution of the human race. By valuing staying away from dangers, the human race was more able to survive. This concept is consistent with the physiological theories about the human brain, which indicates that our "crocodile brain" is wired to feel pain for losing benefits, more than the pleasure for gaining new benefits. (Kahneman et al., 1991; Klaff, 2011)

II.3.5.2 The effect of the time dimension on the valuation of benefits and losses

Employees may not be motivated to try a technology if the benefit they expect out of it is in the distant future while the loss they expect to incur is immediate or in the near future (Fried et al., 2007). The ability to delay gratification, and be patient to wait for long term gains is not a common trait among employees. This ability to resist a temptation of an instant reward for the sake of a later reward is correlated with some skills like patience, willpower, impulse control. (Mischel, 2014)

This concept suggests that when an employee expects Losses (like loss of autonomy, losing power over other colleagues, losing prestige, losing the ability to communicate freely with others and losing mental and physical energy in learning a new skill), he will be inclined to reject the new ICT even if it brings a lot of benefits in the distant future.

This concept means a value of a benefit (x) at time (t₀) is higher than the value of benefit (x) at time (t₁), whereas (t₁) is ahead of time (t₀). This concept could be represented in the form of the following equation:

$$x @t_0 > x @t_1$$

This concept can explain how benefits of some technologies are not attractive enough to some employees who cannot master delaying gratification skill.

II.3.6 Role of Manager's communication abilities in changing employee's frame of reference towards ICT use

As discussed earlier in this chapter, there are two types of needs: Deficit needs and Growth needs (McLeod, 2007). Most needs fall into the Deficit needs type, which means that when these needs are satisfied, their value decrease, as suggested by the graph shown in figure 9. This implies that these needs cannot be the basis on which Managers motivate their employees to adopt an ICT on the long run.

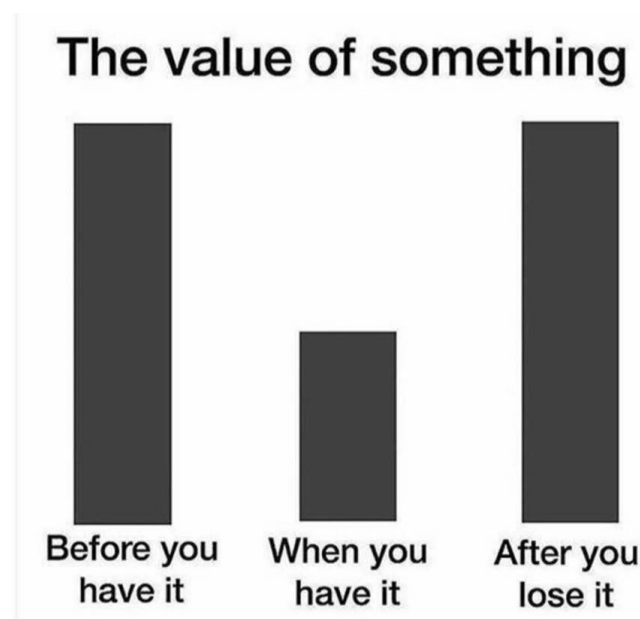


Figure 9 How human being value something that satisfy their "deficiency needs" over time

It is of vital importance to ensure the motivation of an employee to adopt an ICT is based on his growth needs not only his deficit needs. Growth needs do not follow the same behavior indicated by the chart above. A manager should understand the growth needs of his employees, their career goals and their life values, so that he could link the value of the ICT to satisfying these growth goals. (Sinek, 2009). This motivation strategy could serve as the engine for keeping the employee committed to improving his skills at using the ICT and maintaining his acceptance level to the ICT. In the next sections, the literature on fundamental

ways a Manager could implement to convince an employee to bear the struggles of learning a new ICT for the promise of distant future benefits is reviewed.

II.3.6.1 Passing the “Crocodile brain” safety gates

(Sinek, 2009) introduces the idea of starting to convince people using what is known as the golden circle. (figures 5 and 10)

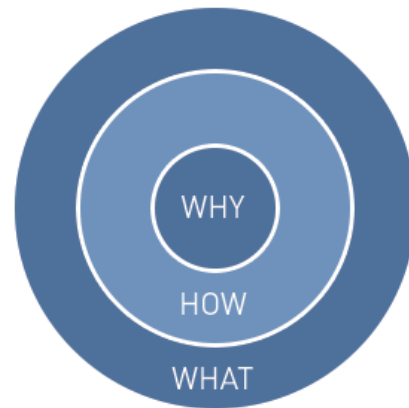


Figure 10 The golden circle vs. the brain structure (Sinek, 2009)

It is argued that the golden circle is homogenous with the structure of the brain, where the crocodile brain needs to perceive a convincing “why” at first, in order to inspire the neocortex to think about “how” to get the desired effect to happen and “what” steps to do to make the desired effect happen. The decision to reject a technology is controlled by the crocodile brain without the neocortex even participating with an input in the decision, in most of the cases.

When a manager clearly communicate the “why” behind the ICT they are introducing, and this “why” resonates with the employee’s own personal “why”, he is willing to withstand hardships of learning and coping with the new ICT. The employee’s personal life goals, career goals, causes he believe in and the impact he wants to leave at work and to the community act as his “why”.

II.3.6.2 Inspiration vs. Manipulation to use the new ICT

Employees may get motivated to use technology when they perceive immediate benefits in using it. However, when they get inspired, they become even willing to suffer discomfort and inconvenience for the sake of successfully adopting the

new technology in their company. When emotional signals by crocodile brain are pushing towards change to feed the desired self-image by the employee, he becomes willing to move miles for making this change happen. *“When decisions feel right, we are willing to suffer inconvenience for them”* (Sinek, 2009)

People need a reason to be inspired to walk through the obstacles of learning to deal with a new ICT. Inspiring change is not usually tied with external incentives and materialistic gains. Sometimes having a higher purpose and believing in what this new technology would bring would be a strong motivation for the employee to start using the new technology. The ability to truly influence employees comes from being “inspired, not swayed” to act. They have to believe in the change that is taking place and this requires honesty and authenticity of the real desired and undesired effect of the new technology, and the overall desired effect has to be more than the overall undesired effect.

Sinek (2009) suggests that there are two ways to inspire action, manipulation and inspiration. Manipulations could be described as increasing materialistic or immediate gains expected out of the negotiated action. While this could be effective at times, the problem is that can make the person really demanding more of the materialistic gain as the time passes. In the context of introducing a new ICT to an employee, materialistic gains could be a salary raise or a promotion. Inducing fear could also be a way of manipulation. Inducing fear of missing out, by saying to the employee that by not adopting this new technology, he will be missing out on opportunities for a pay raise is an example of a manipulation that could be effective in the short term, but is probably not going to be effective in the long term.

Sinek (2009) argue that manipulations do not result in commitment to change or loyalty to a company. They add a pressure on the company to keep finding new manipulations to sway its employees to do the desired action by the company, which is not an effective long term strategy to be used. These manipulations could increase costs of the company by being obligated to pay raises to

employees to keep them motivated to learn and keep using new challenging technologies and bear the disadvantages of these new technologies.

Keeping employees loyal to the company and not looking for options is a costly task when manipulations is a common strategy in the company. If the employees do not find a higher purpose to bearing the discomfort of having to learn a new technology and bear any disadvantages they would have to experience by using this technology, they will look for other options and cause disturbance to the stability and turnover rate inside a company. So unless the new technology is the industry norm in all of the competing companies, forcing a new technology could raise the risk of losing employees to competing companies. The company should think of ways of motivating change that induce the thinking of “we are in this together and we will get along with the discomforts made by the new technology”. (Sinek, 2009)

Sinek (2009) argues that giving people a reason to communicate to other people things about themselves is much more effective than manipulating them into doing actions they don't want to do. For the context of introducing new technology, employees would like to communicate to other people, in and outside the company, that they are proficient in something. They would like technology that can help him communicate messages like “I am sophisticated”, “I help others” or “I make an impact”. Giving employees reasons to communicate these messages can be extremely motivating on the long run. When an employee sees the new technology from this perspective, he will be more willing to adopt it.

II.3.6.3 Authenticity and Trust role

As reviewed in many cases, employees would prefer avoiding the discomfort and pains of learning to use a new ICT, even if they perceive long term benefits out of this ICT. Some studies attributed this behavior with a belief that near future is more certain than distant future. (Michaelson and Munakata, 2016) suggests that having trust in a Manager would increase the employee's ability to delay gratification. That is mostly because increasing trust between a Manager and an

Employee, makes the employee more confident about distant future and more ready to go through discomfort and disturbance of a new ICT now for enjoying benefits later in the distant future. With an analogy of an investor, the employee would be ready to invest time and cost of learning and going through problems, if he is certain that in the future, he would reap the benefits. Authenticity of a manager could raise this level of trust.

(Sinek, 2009) sees that lacking authenticity is attributable to a variance between what the managers do, how the systems and processes are set up in an organization and what the managers say is the “why” behind their actions. An inconsistency of the what, how and why causes lack of authenticity. The employees’ “crocodile brain” can detect this lack of authenticity. In order for managers to lead a change, they have to show authenticity. They have to show a consistence of their intentions and actions.

Trust is strengthened when employees feel a sense of shared values and beliefs with their managers. It is not sufficient for an employee to have a history of being treated right from his manager to induce shared trust. If the employee does not sense that the manager share the same values and beliefs with him, he will doubt everything said by the manager. But when trust is there, there will be real value anticipated by employees, not just immediate benefits of the introduced ICT.

II.4 Dynamic Nature of the problem

The interaction between a manager who tries introducing a new ICT to employee and the employees themselves is a dynamic interaction. This means that the state of variables like “the employee’s acceptance of ICT”, “the effort needed to use an ICT” and “the communication quality between a manager and an employee” change over time. One of the ways to represent the dynamic relations between variables in the literature is the “Causal Loop Diagram”. (Mella, 2012)

II.4.1 Causal Loop Diagram

Causal Loop Diagram method or “CLD” is a method of representing dynamic interactions in a logical sense. The Causal loop diagram Method was not used before in the literature to create ICT acceptance models. However, it should be a good way to represent logical relationships.

A Causal Loop diagram is qualitative modelling technique that connects each variable with its causes and effects, to form sets of loops that explain the behavior of the described system over time. Dynamic systems are systems made up of temporal variables that are connected by loops.

Basic components:

1. The variables and the causal relationships;
2. The variations and the circular reinforcing and balancing processes
3. Delays
4. The system boundaries

By observing–or hypothesizing– the dynamics of a certain number of variables, these models depict the “world” as a system of connections among those variables, allowing us to understand their logical structure, dynamics and unvarying patterns over time and in space.

To start modeling a dynamic system reality should be considered as consisting **not** of objects that compose it but of variables that distinguish those objects, whose temporal dynamics is caused by processes that can be represented as black boxes. (Mella, 2012)

CLD is used to represent all types of “dynamic systems”. Dynamic systems are systems whose state change over time. Dynamic systems can be physical like “A mechanical system of a car” or softer in nature like “Interaction between people”.

II.4.2 Steps of creating a Causal Loop Diagram “CLD”

II.4.2.1 Step 1: Breaking down a system in terms of variables

For the purpose of an easier explanation of the CLD creation steps, a simple example of a car system from the Systems Thinking book by (Mella, 2012) is reviewed. The first step in drawing a CLD that represent a system is to break down that systems in terms of variables. (Mella, 2012) describes this step for a car system as follows:

“Suppose we observe a car going on the road for a specific period of time, an hour for example. if we are trying to model this system, we will not be interested so much in the engine model, how many seats, color, power of the engine, year of production, owner, route taken, where it is going, etc. we can assume these variables are constant over time. However, we will be interested in other variables associated with it: speed, kilometers driven, road grade, pressure on the accelerator and brake pedals, gears, gas consumption, etc.

The values of these variables for the hour-long trip for simplicity’s sake measured at regular intervals; for example, every minute – describe the system’s dynamics. The change of the values of these variables over time represent the behavior of that car as a dynamic system. After defining the interesting variables necessary, to describe the system, we should connect these using arrows– the essential building block of the causal loop diagram– in order to express their connection.” (Mella, 2012)

II.4.2.2 Step 2: Representing cause and effect relationships

(Mella, 2012) links in the following figure the car-related variables in a cause-effect relationship. The arrow represents the cause-effect relationship. Four variables are correlated here, two at a time:

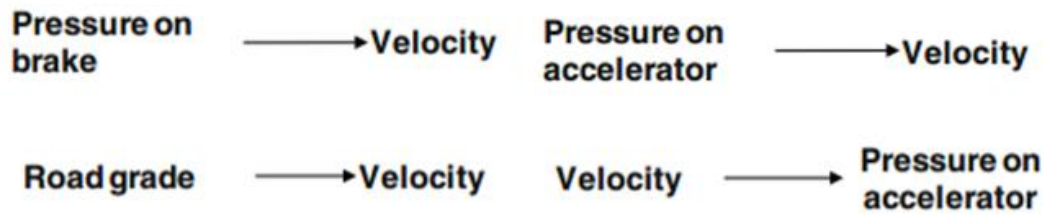
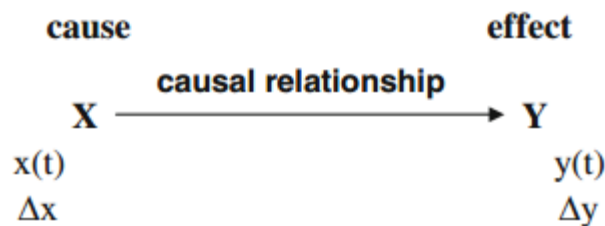


Figure 11 Arrows representing cause-effect relationships

It is obvious that the grade of the road influences car velocity; it is equally clear that the opposite is not true since speed cannot influence road grade. We can generalize: *“Every connection has a significant direction; the arrow must express this”*. The arrow must be oriented to indicate a cause (X) and effect (Y) relationship (link). In the tail (starting point) we indicate the causal variable; in the head (arrival point) the effect variable as shown:



Both X and Y vary with time so they are said to be “temporal variables”

Linking more than two variables

As shown in figure 12, Multiple relations can be expressed:

1. **Co-causes case:** an example is when we consider both the grade and the pressure on the gas pedal at the same time as co-causes of the variation in speed;
2. **Multiple effects case:** example such as when we assume that speed influences both gas consumption as well as travel time.

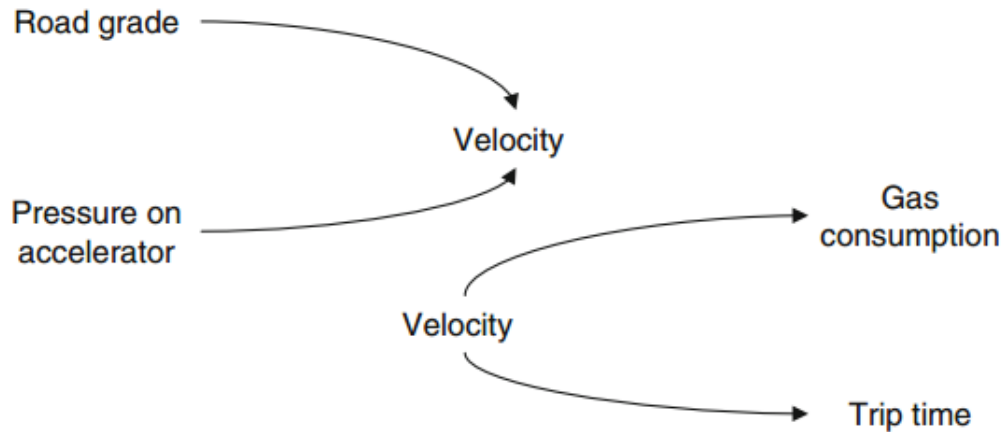


Figure 12 How to represent multiple causes and multiple effects

CLD can represent variables of many types. It can represent psychological variables (satisfaction, anger, stress) as well as physical variables (brakes, gas pedal, speed)

II.4.2.3 Step 3: Representing direction of change

So far, we explained how to represent a “cause and effect” relationship, or how a variable (cause) **changes** another variable (effect). The next step is indicating the **direction of this change**. The direction could be one of two things:

- Same direction (**S**): When two variables “X” and “Y” are linked by an “S” direction, it is said that they vary in the same direction. This means: If “X” increases, “Y” increases accordingly, and if “X” decreases, Y decreases.
- Opposite direction (**O**): When two variables “X” and “Y” are linked by an “O” direction, it is said that they vary in the opposite direction. This means: If “X” increases, “Y” decreases accordingly, and if “X” decreases, Y increases.

Back to the example of the car system, we can represent a relationship between pressure on brakes, wearing of the brake and car velocity as follows.

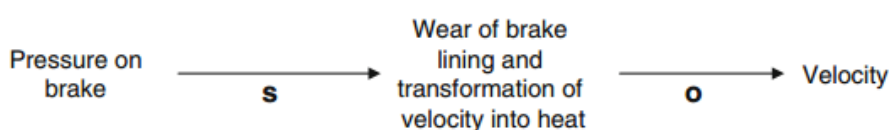


Figure 13 An example of a causal chain

So when a driver increases pressure on the brake, the wearing of the brake increases and the velocity of the car decreases. This representation is called a “causal chain”.

II.4.2.4 Step 4: Reinforcing loops vs. Balancing loops

Let’s say we have a variable “A” and variable “B”. Sometimes, we can find a relation between them where “A” is the cause and “B” is the effect, while at the same time “B” could be a cause for an effect on “A”. This could form two types of loops:

- **A Reinforcing loop:** It is a situation when two variables are interconnected by logical relationships having the same direction
- **A Balancing loop:** It is a situation when two variables are interconnected by logical relationships having opposite directions

Two examples by Mella (2012) are used to explain the causal loops.

Reinforcing loop example: US armaments vs. Soviet armaments



Figure 14 A reinforcing loop

*“Intuition tells us that an increase in U.S. arms will cause an increase in Soviet arms (upper arrow) and that the increase in Soviet arms will result in an increase in U.S. arms. The systems observed with Systems Thinking are recursive and repeat their cycle several times. Thus the loop guarantees that the increase in U.S. arms will produce a further increase in the other variable, with a succession of reciprocal increases that seems unstoppable. The two variables mutually **reinforce** their variations. The opposite dynamics is also true.” (Mella, 2012)*

Balancing loop example: Sardines numbers vs. Sharks numbers in a sea

*“A greater number of sardines provides more food to the sharks, who can thus reproduce in greater numbers. The lower arrow instead shows the OPPOSITE relationship; as expected, an increase in the number of voracious jaws reduces the number of sardines. As this is a recursive system, we repeat the cycle. By reducing the number of sardines we also reduce the number of sharks, which allows the sardines to survive in greater numbers, thus providing food to the sharks, who reproduce quickly, which reduces the number of sardines. Both the number of sardines as well as the number of sharks does not increase continually but only as far as an upper limit that, once reached, initiates a reduction. When the dynamic process reaches a lower limit it reverses trend. The dynamics of the two variables reciprocally **balance** each other”*

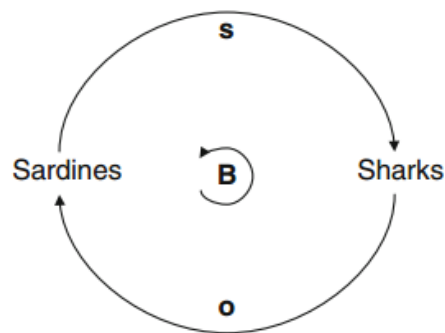


Figure 15 A balancing loop

Drawing these relationships in a graphical form presents ideas in a clear way and eliminates the need for complex explanation using written words.

Chapter III: Research Methodology

The Literature review indicated many factors/reasons that could affect the employee's acceptance of ICT. However these factors were not validated in the Egyptian Construction industry context. The first goal of the thesis is to create a comprehensive list of reasons for resistance of employees to new ICT, stated in construction industry related context and technology acceptance models. The second goal is to validate the list of reasons, created from literature review, is valid in the Egyptian Construction industry context. This validation would show whether the Egyptian Construction Industry employees' behavior is consistent with behaviors described in the Literature.

III.1 Factors Collection and Grouping

Factors were synthesized from the following models and theories:

- Technology acceptance Model "TAM"
- Innovation Diffusion Theory "IDT"
- Combined TAM-IDT Model by (Xu et al., 2014)
- Lazy User Model "LUM"

The following factors were collected and grouped into 4 categories after removing duplicates:

Factors affecting how much Technical effort is needed to learn and use the ICT

1. Compatibility of new ICT's inputs and outputs with existing systems
2. Availability of standards and procedures to guide using the new ICT
3. Compatibility of new ICT's inputs and outputs with other stakeholders systems (subcontractors, service providers,..)
4. Ease of learning to use the new ICT, and availability of technical support and training
5. Reducing time needed for an employee to do deliver his tasks if he used the new ICT system

Factors affecting how much coordination effort is needed to use the ICT

1. Maintaining the same organizational structure with minimal changes after introducing a new ICT system to the company
2. Having a good management system, to control the changes to responsibilities of each employee (made by introducing a new ICT system)
3. Agreements on standards and management procedures to be followed with other stakeholders after the introduction of the new ICT system

Factors affecting the willingness of the employee to use the ICT regardless of how interesting he perceives it

1. The value of learning this new ICT (how appreciated is the skill of using this new technology in the job market and socially between people)

Factors affecting how interesting the ICT is perceived by the employee

1. New ICT having aspects that appeal to the curiosity and personal interests of the employee

A questionnaire was designed to test the validity of the 10 extracted factors in the Egyptian Construction Industry context.

III.2 Validation Methodology

Since the focus of the research is to understand the factors that affect the ICT acceptance in the Egyptian construction industry context, so a questionnaires survey was used to capture the opinions of Egyptian Construction Companies employees. The survey, composed of a series of questions, is intended to understand the perceived importance of some factors in affecting ICT adoption in the Egyptian Construction Industry. The Questionnaire was divided into two sections. First section, collects personal data about the employee. Second section, lists the hypothesized factors under study.

The participant is asked to indicate the importance, of each of the 10 factors under study, on a Likert scale, where:

1= of no importance

2= of little importance

3= important

4= very important

5= extremely important

III.3 Validity of the Questionnaire

The phrasing of questions was simplified to ensure reliable responses from the questionnaires. The following factors were taken into consideration with during the questionnaire design:

- Clarity of instructions
- Questionnaire Length
- Simple phrases
- Consistence of the questionnaire order of questions

Before distribution of the questionnaire, a pilot distribution was done for a sample of 6 construction industry professionals of different levels of proficiency in the English language to ensure the ease of comprehension of the questions. Amendments were made to wording of some phrases.

III.4 Sampling Technique

Sampling involves the selection of a number of study units to represent a target population which is too vast to encompass or is geographically dispersed. The adequate sample size for our research was determined through a statistical formulation previously used for similar purposes by (Yiannoutsos et al., 2008).

Various factors are to be reflected on the sample size chosen, which are:

- Sampling error
- Variation in answers

- Population size
- Confidence level.

The formula to determine the sample sizing is

$$Ns = \frac{(Np)(p)(1-p)}{(Np-1)\left(\frac{B}{C}\right)^2 + (p)(1-p)}$$

Where,

Where Ns = sample size for the desired level of precision, Np = population size, p is proportion of the population that is expected to choose one the response categories, B is acceptable sampling error and C is Z statistic associated with the confidence level, 1.96 corresponds to 95% level.

Our target population was determined through examining the total number of construction contracting companies registered in the Egyptian Federation for Construction and Building Contractors (EFCBC). It was found that, the total number of contractors registered in the “EFCBC” is 26,296 contractors in and the number of registered consulting firms is 884 firm (2017). This makes a total population size of 27,180. Possible changes between 2017 and 2018 numbers are insignificant in our sample size calculation, so numbers of 2017 were good enough for the sample size calculation.

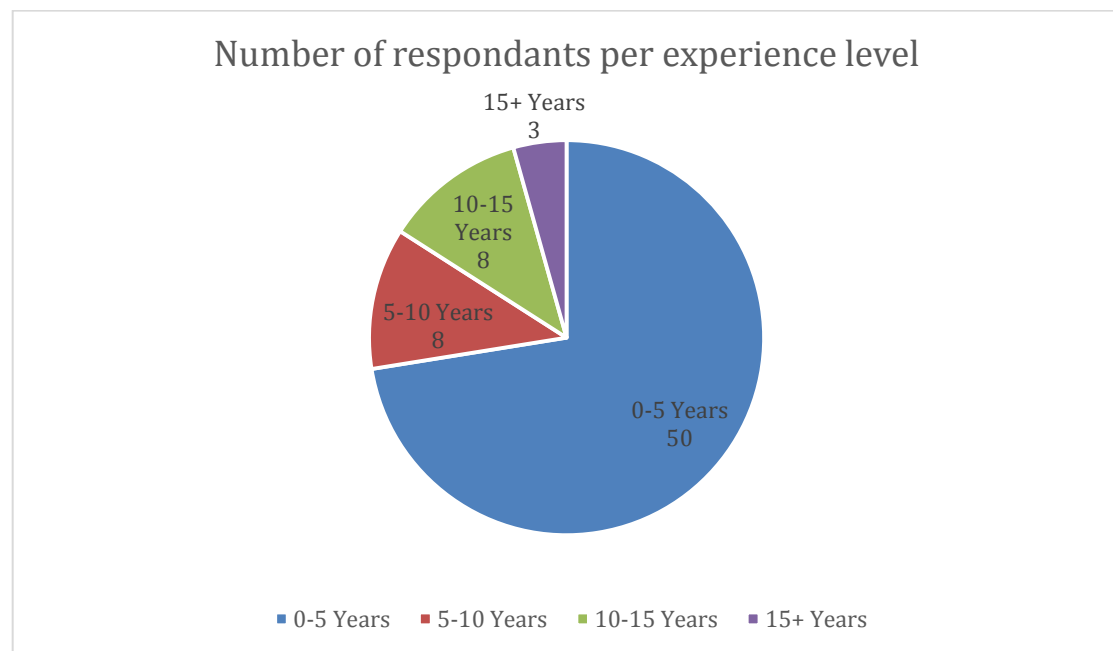
In the construction industry, the response rate of around 30% is considered satisfactory (Black et al., 2000) and a return of 20% of the questionnaire is considered acceptable (Whittaker et al., 1994). For this research, a confidence interval of 10% and the confidence level of 87% will be used. Based on this, the recommended sample size is 61 companies. Each of the 61 companies could be represented by 1 employee.

III.5 Sample Selection

The questionnaire was to be distributed to competent professionals and practitioners in the Egyptian construction industry including owners, consultants, contractors and project managers. The objective was to capture the perception of the Egyptian construction contractors, which is the target

population, in evaluating the main factors hindering the successful technology adoption process in the Egyptian Construction Industry. For this purpose, a representative sample was selected to genuinely reflect the views of the target population.

Out of 92 people invited to participate in the questionnaire, 69 valid questionnaires were received. The sample had people from different experience levels as shown in the following pie chart:



III.6 Results

The survey indicated that all of the 10 factors tested were significant in the Egyptian Construction Industry context. Statistical analysis of the results are shown in the tables 2-5.

#	Factor	Mean	Variance	Standard Deviation
1	Ease of learning to use the new ICT, and availability of technical support and training	4.26	0.8721	0.9339
2	Compatibility of new ICT's inputs and outputs with existing systems	4.13	0.6445	0.8028
3	Availability of standards and procedures to guide using the new ICT	4.32	0.5439	0.7375
4	Reducing time needed for an employee to do deliver his tasks if he used the new ICT system	4.25	0.8649	0.9300
5	Compatibility of new ICT's inputs and outputs with other stakeholders systems (subcontractors, service providers,...)	3.78	1.1138	1.0554

Table 2 Survey results: Factors affecting how much Technical effort is needed to learn and use the ICT

	Factor	Mean	Variance	Standard Deviation
1	Having a good management system, to control the changes to responsibilities of each employee (made by introducing a new ICT system)	4.09	0.6982	0.8356
2	Agreements on standards and management procedures to be followed with other stakeholders after the introduction of the new ICT system	3.75	1.1002	1.0489
3	Maintain the same organizational structure with minimal changes after introducing a new ICT system to the company	3.52	1.2532	1.1195

Table 3 Survey Results: Factors affecting how much coordination effort is needed to use the ICT

	Factor	Mean	Variance	Standard Deviation
1	The value of learning this new ICT (how appreciated is the skill of using this new technology in the job market and socially between people)	3.72	0.9378	0.9684

Table 4 Survey Results: Factors affecting the willingness of the employee to use the ICT regardless of how interesting he perceives it

	Factor	Mean	Variance	Standard Deviation
1	New ICT having aspects that appeal to the curiosity and personal interests of the employee	3.42	1.1002	1.0489

Table 5 Survey Results: Factors affecting how interesting the ICT is perceived by the employee

These results indicate that the behavior of employees in Egyptian Construction companies is consistent with the described behavior in the widely accepted models in the literature.

Chapter IV: “The Evaluation tool” development and validation

In the last chapter, the behavior of the Egyptian Construction Industry employees was validated to be consistent with the described behavior in the literature. 10 reasons behind the employees’ resistance to ICT were extracted and grouped. The goal of this chapter is to allow managers to have practical use out of the knowledge in the last chapter. More specifically, the goal of this chapter is to create a list of questions that a manager needs to answer in order to predict whether the employees will accept or reject the new proposed ICT. This list of questions will be called “The Evaluation tool”.

IV.1 Development of “The Evaluation tool”

The 10 validated factors from the last chapter were synthesized in the following logic to develop an “Evaluation tool”:

After a manager introduces a new ICT in the workplace, an employee’s life at work changes. The ICT alters the scope of work so an employee is required to do some new activities and stop doing some of the old activities. This type of new activities is called in this thesis **“The technical activities”**.

Introducing a new ICT tool, equipment or system involves adding new technical activities and removing some of the old technical activities that mostly belong to one of the following 9 categories: (collect, transmit, store, process, visualize, communicate, retrieve, report or present data). (“Information and communications technology in construction - Designing Buildings Wiki,” n.d.)

When scope of work changes for different employees, disputes over managerial positions, important roles and “who-controls-whom” arise. These disputes are mostly indirect and subtle between employees. These disputes give birth a new category of activities that are necessary to survive in the new work environment. This category of activities is called **“Coordination activities”**.

An employee in a construction company works in a team, receives input from other employees, sends output to other employees, reports to managers and manages subordinates activities. There are a lot of interpersonal relations that take place between employees in order to work as a team. Introduction of new ICT tools and systems alters the interpersonal relationships between employees. The employee working in a team needs to coordinate deliverables, timings and other issues with his team and with other stakeholders. Explicitly identifying coordination activities highlights the fact that they need effort and some employees like doing them while others do not like them.

Each activity, whether technical or coordination activity:

- Will need effort to be done
- An employee may find it interesting
- An employee may be willing to do it regardless of how interesting he finds it

IV.2 The Developed “The Evaluation tool”

Using the synthesis in the last section, the following tool was created:

Identifying main activities associated with the ICT introduction to the company: Introducing a new ICT tool, equipment or system involves adding new activities and removing some of the old activities for some of the employees. The activities belong to one of the following 9 categories: <i>(collect, transmit, store, process, visualize, communicate, retrieve, report, present)</i> data		
Factors Employee uses for Evaluation of each activity		
Effort -How much effort is needed to learn this activity? -How much time is needed to learn this activity -How much effort is needed to do this activity? -How much time is needed to do this activity?	Interest -Is learning this activity intriguing for the employee? -Is doing this activity entertaining for the employee?	Willingness -Is this activity valued and perceived important by other people? -Is this activity aligned with the career goals of the employee? -Is this activity self-fulfilling to the employee?
When considering that an employee works in a team, receives input from other employees, sends output to other employees, reports to managers and controls subordinates activities: A new type of subtle activities arise that belong to one of the following 3 categories: <i>Coordination activities – Negotiation activities – Control Activities</i> Over Deadlines - Responsibility of unwanted tasks - Formats to use Introducing a new ICT adds new activities and remove some of the old ones for some of the employees.		
Factors Employee uses for Evaluation of each coordination activity		
Effort How much effort is spent coordinating and negotiating: - Responsibility of uninteresting activities? Whose employee's scope does it fall into? - Deadlines? - In what form to receive the data?	Interest -Does the employee like to engage in these activities? -Is the employee skilled in handling these activities?	Willingness -Does the employee get controlled by other employees in a way he dislikes? -Does the employee get more control over other employees?

Figure 16 "The Evaluation Tool"

This Evaluation tool is intended to be a diagnostic tool to be used by managers experiencing problems after adopting a new ICT in their company. It is intended to contribute in revealing the behavioral drivers behind the resistance towards a new ICT. For example, it may be concluded after using this tool that the problem is more managerial than technical, that the new ICT is hard to learn or that the employees lack a driving goal to bear the discomfort of learning to use a new ICT system/tool.

IV.3 Action Steps to use the tool

The developed tool could be used by applying the following action steps:

- Identifying, per employee, the main technical and coordination activities associated with the ICT introduction to the company.
- For each employee, list all technical and coordination activities associated with the ICT introduction to the company:
 - For each **technical activity**, ask the following 9 Questions:
 1. How much effort is needed to learn this activity?
 2. How much time is needed to learn this activity?
 3. How much effort is needed to do this activity?
 4. How much time is needed to do this activity?
 5. Is learning this activity intriguing for the employee?
 6. Is doing this activity entertaining for the employee?
 7. Is this activity valued and perceived important by other people?
 8. Is this activity aligned with the career goals of the employee?
 9. Is this activity self-fulfilling to the employee?
 - For each **coordination activity**, ask the following 7 questions:
 1. How much effort is spent coordinating and negotiating the Scope and Responsibility of uninteresting activities?
 2. How much effort is spent coordinating and negotiating deadlines?
 3. How much effort is spent coordinating and negotiating in what form to receive the data?
 4. Does the employee like to engage in these activities?
 5. Is the employee skilled in handling these activities?
 6. Does the employee get controlled by other employees in a way he dislikes?
 7. Does the employee get more control over other employees?
- Complete this assessment for all activities per employee. Then do the same assessment for all the employees concerned with the ICT introduced.
- Get qualitative insights about what might cause a resistance to the new ICT

IV.4 Validation Methodology

The goal of this section is to validate the reliability of the developed tool and assess its applicability in practical usage by construction industry practitioners in Egypt. Validation of the qualitative tool was done through the method of external validity.

Experts with practical experience in the construction industry in Egypt were contacted to validate the tool. Out of 11 contacted experts with 10+ years of experience, 9 experts agreed to participate in the validation exercise. Data about the participating experts is presented in Table 6.

Respondant no.	Initials	Experience	Field
R1	MA	25Y	Project Management
R2	HB	27Y	Cost Management
R3	KM	13Y	Project Management
R4	MI	13Y	Contracts Management
R5	AG	10Y	Cost & Risk Management
R6	AA	12Y	Tendering
R7	MS	11Y	Cost Management
R8	ME	12Y	Planning
R9	AR	11Y	Contracts Management

Table 6 Experts participating in validating the Evaluation tool

The participants were given the model without explaining its details. They were inducted that the model should be used as a diagnosis tool post the introduction of a new ICT system or a tool to a Construction company. Then, they were handed out questionnaires consisting of the following four questions:

1. Is the Evaluation tool easy to comprehend by leaders in the Construction Industry in Egypt?
2. Does the Evaluation tool help narrow down the search about the reasons behind slow ICT adoption?
3. Is segmenting activities into technical activities and coordination activities useful?
4. Do you think the Evaluation tool could trigger the user's insights about different ways to solve the ICT adoption problem?

They were asked to answer the questions using a Likert scale, where:

1= Strongly Disagree

2= Disagree

3= Fairly Agree

4= Agree

5= Strongly Agree

IV.5 Results

The results of the questionnaire showed that the Evaluation tool could be used as a diagnostic tool by construction industry leaders in Egypt to assess main drivers behind slow ICT adoption. Respondents R3 and R5 highlighted the importance of finding a way to answer questions quantitatively. Respondent R4 suggested that complementing the Evaluation tool with a personality type assessment like the Myers Briggs Personality Type Indicator (Myers et al., 1998) could give useful insights to answering the questions of the Evaluation tool.

Question	R1	R2	R3	R4	R5	R6	R7	R8	R9	Mean	Standard Deviation
Q1	4	4	5	3	5	4	3	4	5	4.11	0.782
Q2	5	5	5	5	4	5	4	5	5	4.78	0.441
Q3	3	4	4	4	3	4	4	5	5	4.00	0.707
Q4	4	4	3	5	4	4	5	5	5	4.33	0.707

Table 7 Results of Evaluation tool Validation Survey

IV.6 Discussion

Using the developed tool, problems a company faces after a new ICT is adopted in the workplace could be categorized into two main buckets:

- Technical Problems
- Coordination Problems

Under each bucket, there are three main drivers of the problem:

- Too much effort is needed to use the ICT.
- The ICT is not interesting enough to the employees.
- The ICT is creating a situation that employees are not willing to go through. The goals of the employees are irrelevant to the problems created by the current situation.

By going over the set of questions in the Evaluation tool, for each employee, a manager could generate some insights on what might be the underlying problem behind slow ICT adoption in his company and ignite a creative problem solving process in his company.

Chapter V: “CLD Model” Development and Validation

In the last two chapters, factors determining the expected level of resistance were collected mainly from models that were used in the context of “Employees’ ICT acceptance”. However, there are other behavioral aspects that were not used before in the context of “Employees’ ICT acceptance” like the managers’ attitude, the needs and fears of employees and miscommunication effects. These factors are hypothesized to be significant in the “Employees’ ICT acceptance” context, but they were not used in any of the models before. The aim of this chapter is to complete the big picture, integrate aspects from different research tracks and create a better understanding of the ICT acceptance problem by developing a model that can capture the dynamic nature of the problem. The modeling method that is used in this chapter is the Causal Loop Diagram “CLD” method.

Steps of developing the Causal Loop Diagram:

- Draw Causal chains that represent the logical relations behind the 10 factors used in the last 2 Chapters.
- Attempt to extend the causal chains by adding more aspects of the ICT acceptance problem.
- Look for loops in the extended chains to complete the Causal loop diagram.

V.1 Model Development

V.1.1 Representing the 10 factors in Causal Chains

These are the 10 factors represented in causal chain form:

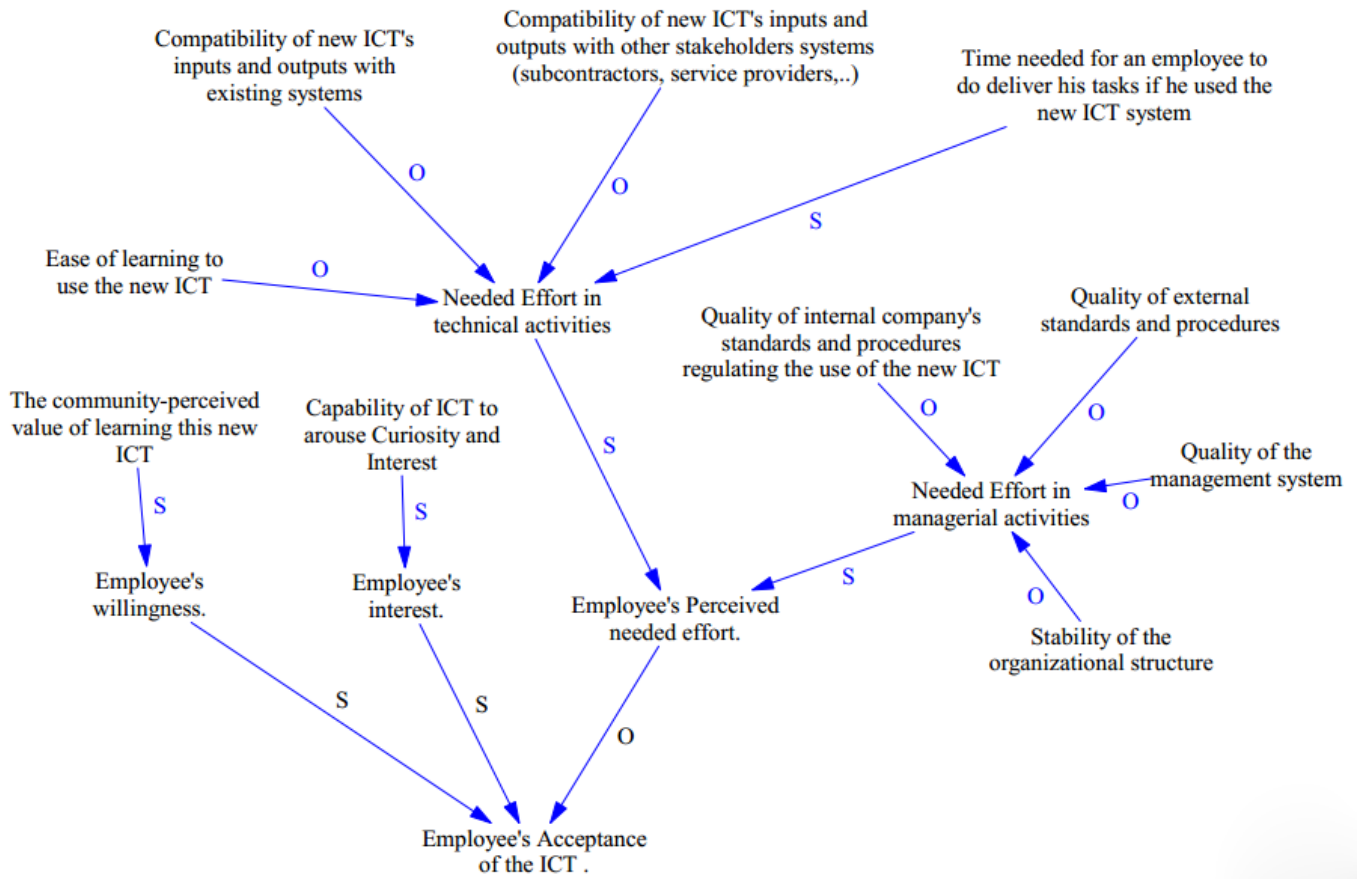


Figure 17 Causal chains representing the 10 validated factors

V.1.2 Extending the Causal Chains

The model was enriched by including the following communication-related factors:

- The effect of communication interventions of a manager on employee's perception of how good the situation is after ICT is adopted in the company.
- The bias of an employee's frame of reference in making sense of a manager's trials to convince him with the new ICT.
- The effect of having career and life goals that are aligned with the new ICT

The above three phenomena could be summarized in the following diagram:

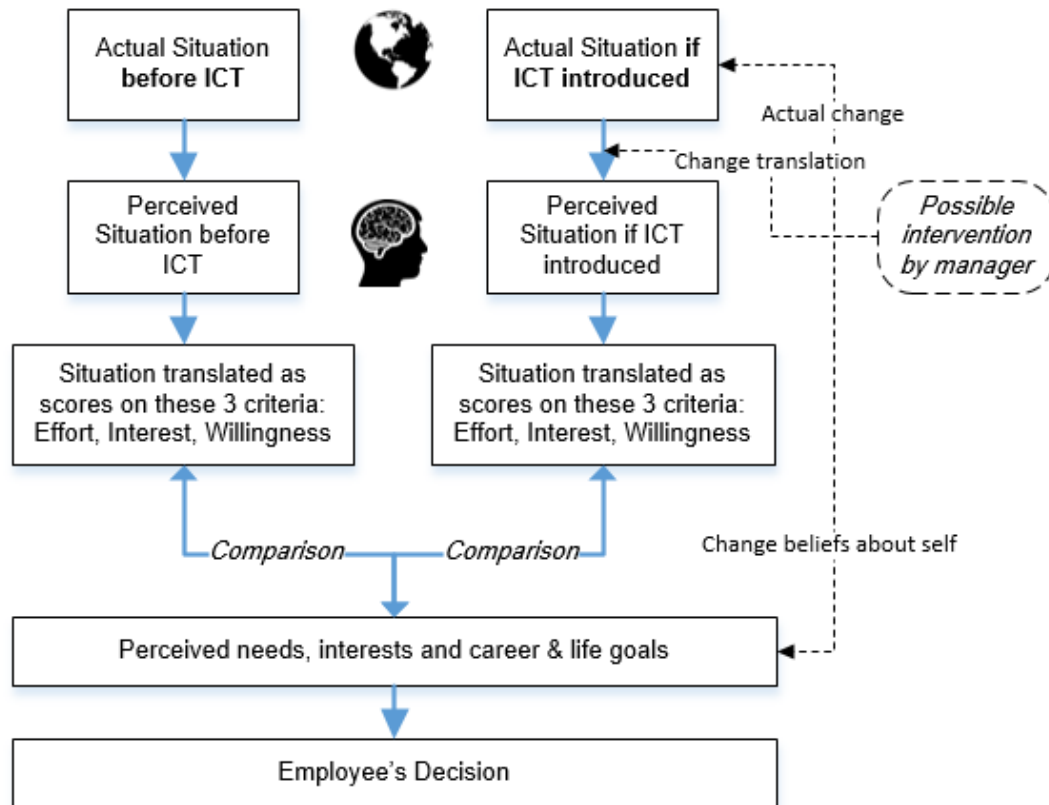


Figure 18 Changing "actual" situation of an employee vs. changing the "perception" of the employee about that situation

Other Factors to be included:

- The effect of the company's overall performance on the employee's acceptance of ICT

The model in figure 19 was created to represent the previous phenomena:

- H4: As the employee's career goals become more aligned with the skills he needs and the impact of the ICT, his willingness to use the ICT increases.
- H5: As the employee become more skilled in using ICT, he needs less effort to use it.
- H6: As the employee receives trainings on ICT, his skill in using this ICT is likely to increase.
- H7: As the employee's willingness and eagerness to use the ICT increases, he is more likely to spend time in acquiring the skills needed for using an ICT.
- H8: If the employee experiences more technical problems while using the ICT, he tends to believe that it needs more effort from him to use it.
- H9: If the employee faces more coordination problems with his colleagues while using the ICT, he tends to believe that it needs more effort from him to use it.
- H10: If the employee likes and accepts the ICT he is using, his performance and results are likely to increase.
- H11: If the employee's performance increases, the manager will spend less one-to-one meetings with him trying to raise his performance.
- H12: If the employees' individual performance increases, the overall company performance and results are likely to increase.
- H13: If the company's results are good, the company is likely to continue using the ICT it introduced earlier.
- H14: When an employee knows that the company is likely to continue using a certain ICT for a long period of time, he is more likely to invest his time on training on this ICT.
- H15: When a manager motivates an employee towards using an ICT, his acceptance of the ICT is likely to increase.
- H16: Unintended triggering of fears due to miscommunication could happen during a manager's efforts to motivate an underperforming employee.

- H17: As the communication skills of a manager increases, he is less likely to trigger unintended fears while talking to the employee.
- H18: If the employee's fears increase, he is less inclined to accept the ICT introduced to him.
- H19: As the overall company performance increases, the manager is likely to have more budget, so his willingness to invest in solving ICT problems increases.
- H20: As the manager spends more money on ICT, technical ICT problems are likely to decrease.
- H21: As the manager spends more money on ICT management excellence, ICT organizational and coordination problems are likely to decrease.
- H22: As the manager has more budget, he is more likely to spend on training his employees on the ICT.

V.2 Action Steps to use the model

The developed model can be used by applying the following steps:

- Pick any of the variables in the model
- Trace the arrows from that variable to the "Employee's Acceptance of ICT" Variable.
- Count the number of "O" letters along the traced arrows path
 - If number is odd: This means that an increase in this variable decreases the "Employee's Acceptance of ICT".
 - In this case, brainstorm with the top management team different ways to decrease this variable
 - If number is even: This means that an increase in this variable increases the "Employee's Acceptance of ICT".
 - In this case, brainstorm with the top management team different ways to increase this variable
- Do the same procedure for all of the variables in the model
- Document the brainstormed ways to increase the "Employee's Acceptance of ICT"

- Prioritize the most efficient ways to increase the “Employee’s Acceptance of ICT” that are compliant with the corporate policies

V.3 Validation Objectives

The goal of this section is to validate the developed model. Three main objectives of the validation phase:

- Ensure that the hypotheses reflect real situation in the Egyptian construction companies.
- Validate the compatibility of literature review, used to generate the hypotheses, with the situation in the Egyptian construction companies.
- Ensure that the model could be used as a practical tool by managers intending to introduce a new ICT in Egypt.

V.4 Validation Methodologies

To ensure reliability of the generated model, external validity approach was chosen. The external validity helps with understanding to what extent the model could be generalized. Two models to achieve external validity are:

1. Sampling Model: This model identifies the population on which the model could be generalized, then a sample size is decided and research is conducted (Creswell and Miller, 2000)
2. Proximal Similarity Model: This model determines the different generalization contexts regarding place, time and people. As a result, a similarity gradient upon which the model could be generalized on is created.

In this research, the generated model is intended to help managers of Egyptian construction companies plan the introduction of ICT into their company.

Therefore, the sampling model deemed suitable for external validity.

V.5 Chosen Validation Methodology

To start the external validity, 17 experts were asked to participate in the validation exercise, out of which the following 12 welcomed participation.

Respondant no.	Initials	Experience	Field
1	MA	25Y	Project Management
2	HB	27Y	Cost Management
3	KM	13Y	Project Management
4	MI	13Y	Contracts Management
5	AG	10Y	Cost & Risk Management
6	SS	5Y	Project Controls
7	MS	5Y	Project Controls
8	HS	15Y	Management Consultant
9	AW	15Y	Management Consultant
10	MB	11Y	Management Consultant
11	SG	3Y	Technology Consultant
12	AH	4Y	Technology Consultant

Table 8 Experts participating in validating the model

The participants were chosen with different experience levels and Fields, as shown in the table above. 5 experts worked in the construction industry for 10-27 years in Egypt. 2 engineers with 5 years of experience experienced a new ICT system introduced in a JV between an Egyptian contractor and an Italian Contractor in a construction project in Egypt. 3 participants were experts in organizational restructuring and digital transformation of companies in Middle East and performed transformation projects on 1-2 Egyptian contractors in Egypt. 2 participants were junior Technology Consultants who introduced ICT

systems to companies in Egypt. Diverse backgrounds and functions of participants who are familiar with Egyptian Employees culture and mentalities would help to know the generalization possibility of the model.

The participants were contacted via phone calls and one-to-one meetings were scheduled. The meetings went as follows:

- The participant is inducted about the purpose of the study
- The concept of causal loop diagrams is explained to the participant
- The model is shown to the participant, and the participant is told that the model is built on 22 hypotheses.
- The participant is asked to confirm the hypotheses on a Likert scale (1-strongly disagree, 2-disagree, 3-fairly agree, 4-agree and 5-strongly agree). The participants were told that some hypotheses may look like common sense to them, but they are stated for the sake of completeness.

V.6 Results

The results of the hypotheses validation are presented in table 9:

Hypothesis no.	Mean	Variance	Standard deviation
H1	4.917	0.044	0.209
H2	4.833	0.079	0.282
H3	4.917	0.044	0.209
H4	4.250	0.393	0.627
H5	4.833	0.175	0.418
H6	4.917	0.044	0.209
H7	4.750	0.107	0.327
H8	5.000	0.000	0.000
H9	4.833	0.079	0.282
H10	4.917	0.044	0.209
H11	4.750	0.107	0.327
H12	5.000	0.000	0.000
H13	3.917	0.139	0.373
H14	4.917	0.044	0.209
H15	5.000	0.000	0.000
H16	4.083	0.329	0.574
H17	4.917	0.044	0.209
H18	4.000	0.190	0.436
H19	4.000	0.286	0.535
H20	4.917	0.044	0.209
H21	3.833	0.270	0.519
H22	4.000	0.286	0.535

Table 9 Model Validation Results

The 12 participants who validated the model agreed that the hypotheses reflected reality of the situation in Egyptian construction companies. All participants agreed that the model would serve as a good brainstorming tool to plan interventions by managers. All participants agreed that the model follows a logical sequence that is a close reflection of reality.

V.7 Discussion

The model developed could be used in creative problem solving method, by broadening the thinking of the top management to include many levers (technical, managerial and communication levers) which can affect the adoption of ICT in a company.

The model encourages innovation in thinking of all the possible ways to influence the variables included in the model. Moreover, this model should serve

as a preliminary model. There is potential to add more variables, think of more external factors that could influence the ICT adoption process and add them to the model using the Causal Loop Diagram logical language.

The model developed is a high level conceptual model, which means it should help top management think about improvement areas to focus on. However, once focus areas are decided, a more technical detailed assessment of the situation would need to be done with less senior Managers.

The Model developed explains the dynamic interaction between a company manager and an employee, when the manager tries introducing a new ICT at the workplace using “causal loop diagram method” to better understand underlying possible levers that the Manager could work on to increase chances for a successful ICT adoption.

Chapter VI: Conclusions and Recommendations

VI.1 Summary

In this thesis, the objective was identifying the factors that affect the employee's acceptance of new ICT at the workplace. Different technology acceptance models were reviewed and collected all the factors were collected from them. Then these factors were validated in the Egyptian Construction Industry context to indicate that the behavior of employees in Egyptian Construction Industry is consistent with the described behavior in the literature. A practical "Evaluation tool" was created using the validated factors, in order to be used by managers to assess the likelihood of an ICT getting accepted if it is introduced.

Then new aspects of the technology acceptance problem that were not mentioned in previous models were woven together with the validated factors from past models to create a new Causal Loop Diagram method that is comprehensive of Technical, Managerial and Communication related aspects of the problem. The model was validated through interviews with experts in the Egyptian Construction Industry.

VI.2 Discussion

By carefully synthesizing the work done in this thesis that attempted to explain the behavior of the employees in reaction to new ICT, three analogies could be made.

VI.2.1 First analogy: Employees behave like Investors

An investor has some assets and money. He never spends any of his money unless he gets a high Return on Investment "ROI".

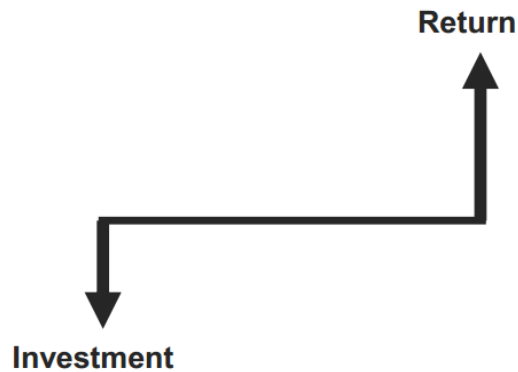


Figure 20 Return on Investment" principle

The x-axis represents time, while the y-axis represents money.

Likewise, an employee has 4 main types of assets: his physical resources (his effort, health and money), his mental resources (his brain health and entertainment), his Social Value inside the company and his Self-Worth (how skilled and how valuable the employee is in his own eyes). An employee will be willing to spend effort to learn and use a new ICT only if he anticipates an increase in any of his resources as a payback.

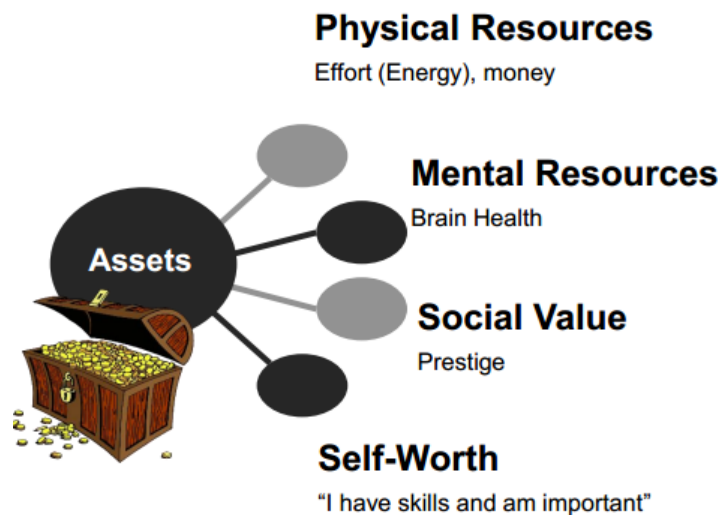


Figure 21 the employee's assets

VI.2.2 Second analogy: Employees behave like babies

In an experiment by a philosopher called Karl Gross. Babies are given a toy with a button. When babies press the button they hear a sound and become very happy. It was thought that the babies are happy because of the sound. However,

it was found that they are happy because they learn that they can make an influence on the external world. And since they can have an impact on the world, so they exist. This happiness was labeled “the pleasure of being a cause”. On the other hands, when the babies pressed the button and did not hear a sound anymore, they experienced deep rage and anger. This rage was labeled “the trauma of failed influence”.(Graeber, 2018)

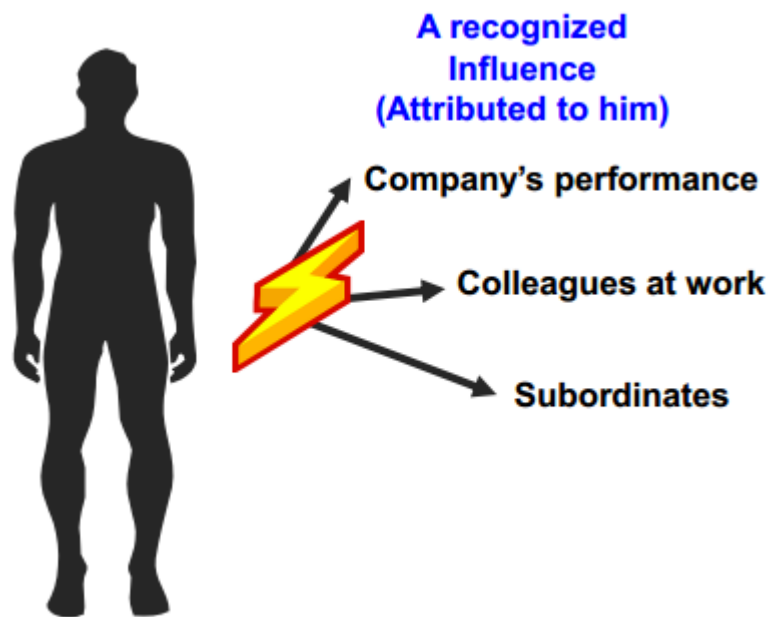


Figure 22 an employee's influence inside his company

Likewise, employees have a certain level of influence in their company before an ICT is introduced. They have influence on a portion of the company's important scope of work, they help and inspire some of their colleagues and receive respect and friendships in return and they manage some subordinates where they are seen as skilled and capable in doing the job the way it is before an ICT is introduced. When an ICT is introduced, disturbance to these influence levels may occur and subsequently cause “the trauma of failed influence”. When this is the case, the employee will reject the ICT.

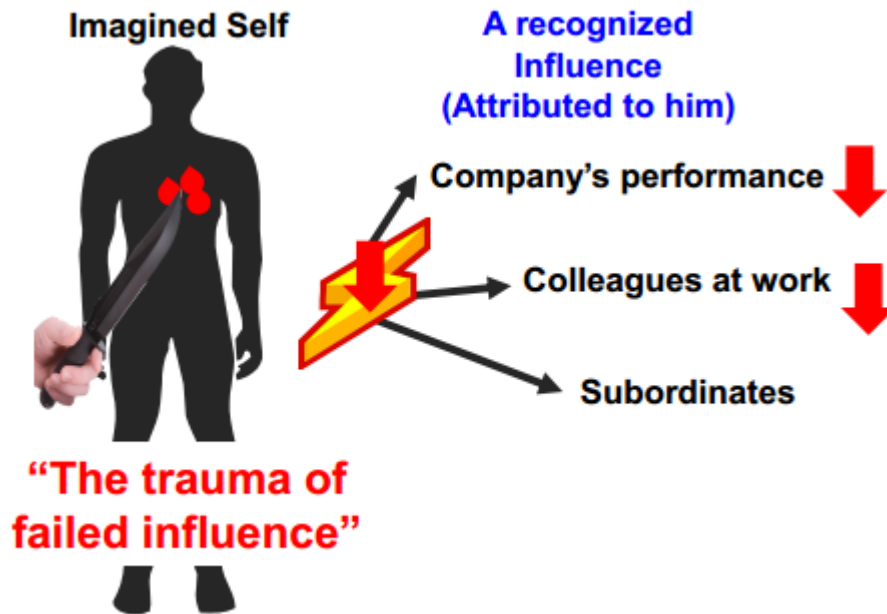


Figure 23 the trauma of failed influence applied to employees

VI.2.3 Third analogy: Employees behave like cavemen

Cavemen used to be surrounded by predators frequently. Their brains were programmed to run away from threats no matter what opportunity they anticipate. While humans evolved, their brains are still programmed in the same way. (Harari, 2014b) Employees still run away from any threats to their assets or influence the same way a caveman runs if he sees a predator.

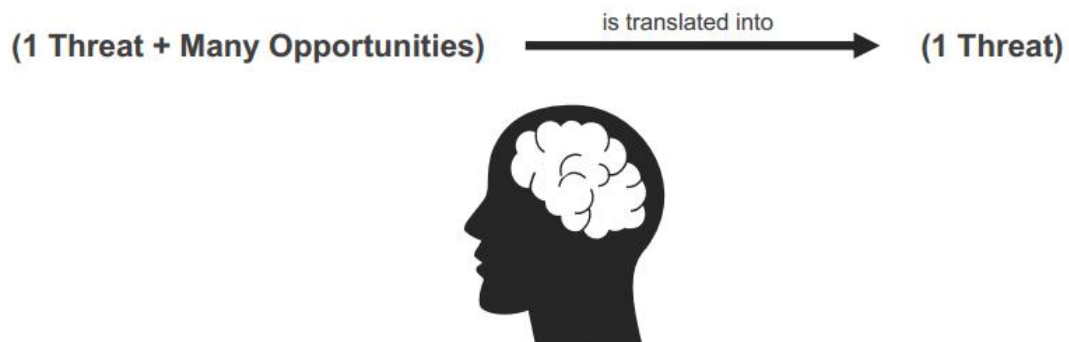


Figure 24 Interpretation of threats and opportunities

VI.3 Conclusion

This thesis collects disperse aspects of the problem from psychology and construction related literature. Connections between collected ideas are found

and a comprehensive logical model is formed. So for example, the lazy user model indicated that if a technology needs a lot of effort to be used, the user will not use it, while the Technology acceptance model indicated that perceived usefulness and perceived ease of use are what determines whether a technology will be used or not. The developed model in this thesis combined both views, and a lot of other aspects. The most significant aspects combined in the model are listed in the below bullet points:

- There is a distinctive difference between the objective reality of a company situation, which recently introduced an ICT, and the subjective perception of each employee of this situation. It is of vital importance to understand the subjective perception of construction industry employees in Egypt.
- The subjective perception of each employee could be expressed in terms of needed effort to use the ICT, how interesting the ICT is to him, how much discomfort the ICT would bring him compared to his willingness level.
- Miscommunication could make the perceived situation worse than what the objective reality really is.
- A manager could increase chances of successful ICT adoption by working on the following three main levers:
 - Changing the actual situation
 - Solving technical problems
 - Solving coordination and managerial problems
 - Changing the perception of the situation
 - Building trust with employees
 - Linking the problems they have to go through with their personal career and life goals
 - Improving his communication skills to avoid unintentional triggering of employees concerns and fears
 - Changing the employees beliefs about their own needs and goals
 - Fixing the employee's beliefs about their needs and what they should be working towards

The thesis work concludes that psychology related problems concerning coordination and change management issues receive much less attention by managers, yet they are extremely significant in affecting the employees' acceptance of new ICT.

VI.4 Recommended Plan of Actions

In order to increase likelihood of employees accepting new ICT in a company, the following course of actions is recommended:

- Assess the company situation clearly using the developed “Evaluation tool”. Detailed steps are in section IV.3.
- Brainstorm solutions using the developed “CLD model”. Detailed steps are in section V.2.
- Educate the top management about how to implement changes to ICT in the company without threatening any of the employees Assets of Influence levels in the company.

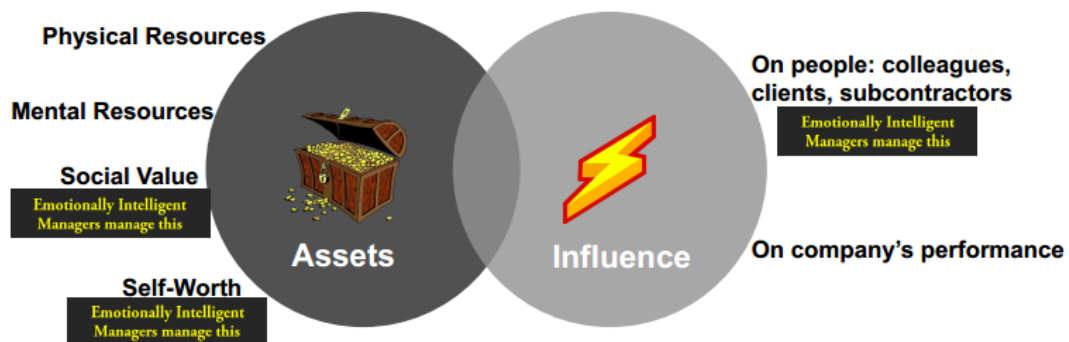


Figure 25 an employee's assets and influence levels that managers should learn not to harm

- After trying all the possible ways to increase the ICT acceptance for employees, it is important to note that some employees may not fit in the company and lack the needed personal goals to be an efficient member in the company. In this case, layoffs may be a necessity.

VI.5 Limitations and Future recommendations

This research focuses on behavioral aspects of the ICT adoption problem more than technical aspects. This focus could make the research limited in uncovering all the obstacles behind the ICT adoption in Egyptian Construction companies.

The thesis is concerned with ICT in general. Different types of ICT innovations may behave differently. More studies on specific types of ICT in the Egyptian Construction industry context are needed.

The validation methods used in this thesis are based on opinions of participants in questionnaires and interviews. Longitudinal studies aimed at revealing obstacles behind ICT adoption process in Egyptian Construction companies could be more objective and generate less biased results.

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